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SEPTEMBER 1949

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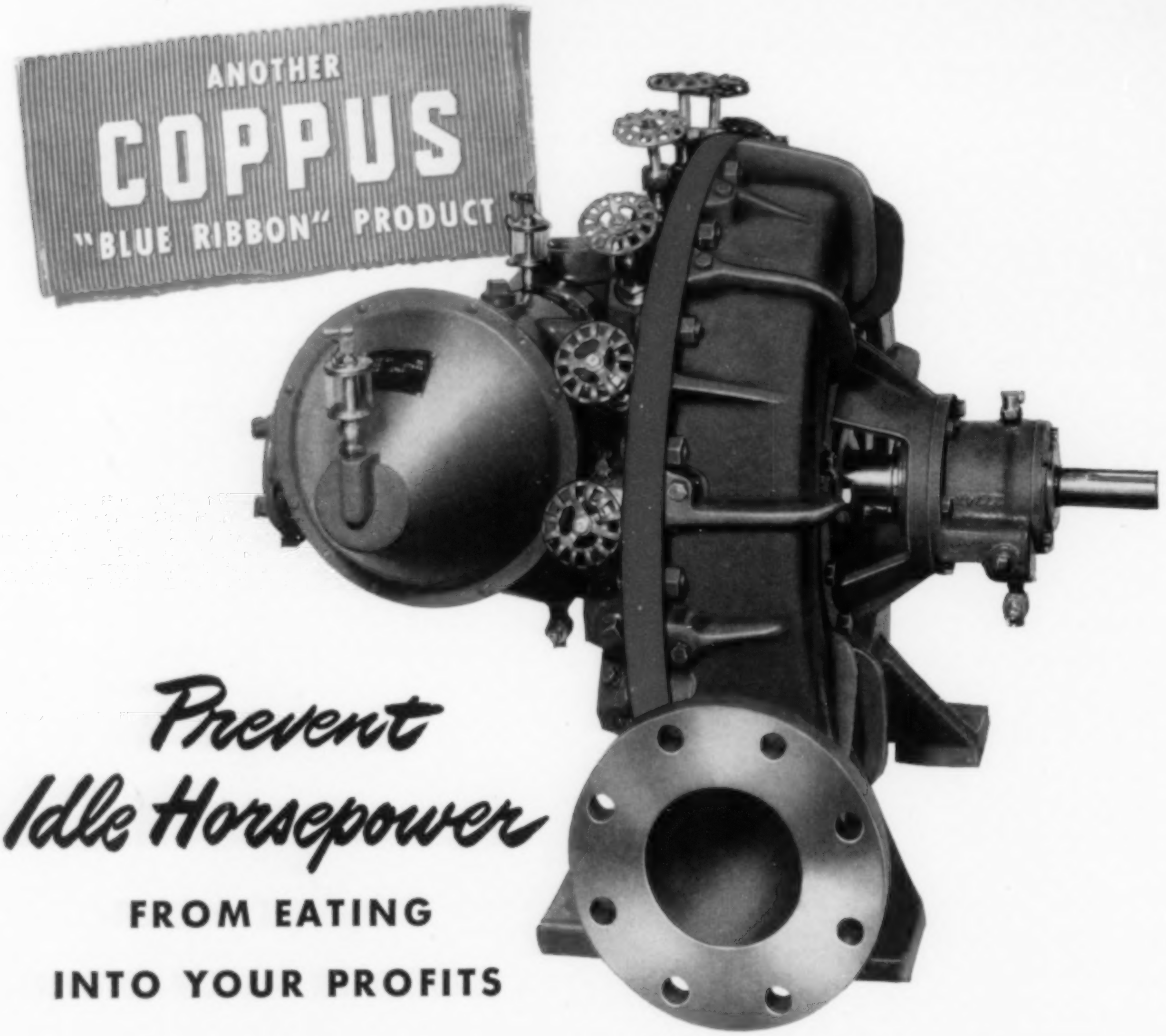
LANDING STRIP
AT TAYOLTITA

Postage-stamp airfield in
bottom of canyon serves
Mexican mining camp

(SEE INDEX PAGE AND PAGE 230)

VOLUME 54 · NUMBER 9
NEW YORK · LONDON



Prevent Idle Horsepower

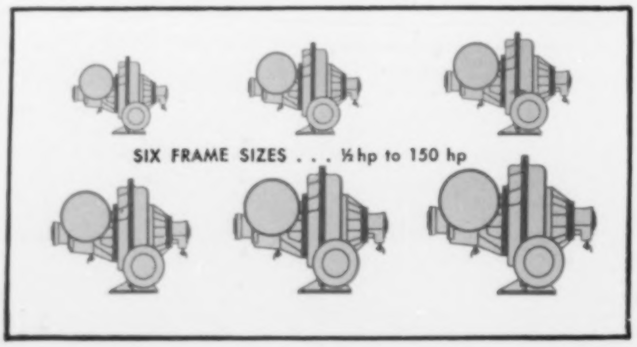
FROM EATING INTO YOUR PROFITS

Paying for a larger turbine than you need is a waste of money you can easily avoid. Coppus "Blue Ribbon" Turbines are designed to meet small-power requirements exactly. Made in six frame sizes — fractional to 150 hp, and priced accordingly — they're hard-working, smooth-running, always dependable . . . the logical, economical drives for your pumps, blowers, fans and similar equipment.

Coppus precision-builds these rugged performers, checks their close tolerances with Johansson blocks, gives each a thorough dynamometer test before shipment. That's why you can count on them for the cost-saving efficiency built into all Coppus "Blue Ribbon" products — blowers, ventilators, gas burners, etc.

Since 1937, over 85% of all orders for Coppus Turbines have been repeat orders. Add their rapidly increasing use on top-name original equipment and you have conclusive proof of their ability to make good on the job — *your* job.

Send for Bulletin 135-10 COPPUS ENGINEERING CORPORATION, 209 Park Avenue, Worcester 2, Mass. Sales Offices in THOMAS' REGISTER. Other products in BEST'S SAFETY DIRECTORY, CHEMICAL ENGINEERING CATALOG, REFINERY CATALOG.


SIX FRAME SIZES . . . ½ hp to 150 hp

WHY PROTECTOMOTOR INTAKE FILTERS ARE BEST FOR AIR COMPRESSOR USE ★ ★

★ HIGH EFFICIENCY WHEN INSTALLED

Protectomotor Air Filters for internal combustion engines and compressors feature dry-type filtering media. These media are selected to fit particular installation conditions. They have been scientifically tested in the laboratory and proven by field use. Used in combination with the patented Radial Fin Insert Construction, they provide highest operating efficiency.

★ INCREASED EFFICIENCY WITH USE

Protectomotor filtering efficiency actually *increases* when dust begins to accumulate on the surface of the media, since this forms a precoating or filter-aid of the very material which is being handled.

★ LOW RESTRICTION TO AIR FLOW

Protectomotors at maximum ratings offer initial resistance to air flow of less than ½″ of water. Since the exclusive Radial Fin Construction provides a maximum of filtering area, this resistance is held to a minimum throughout the life of the filter.

★ SERVICING SELDOM NECESSARY

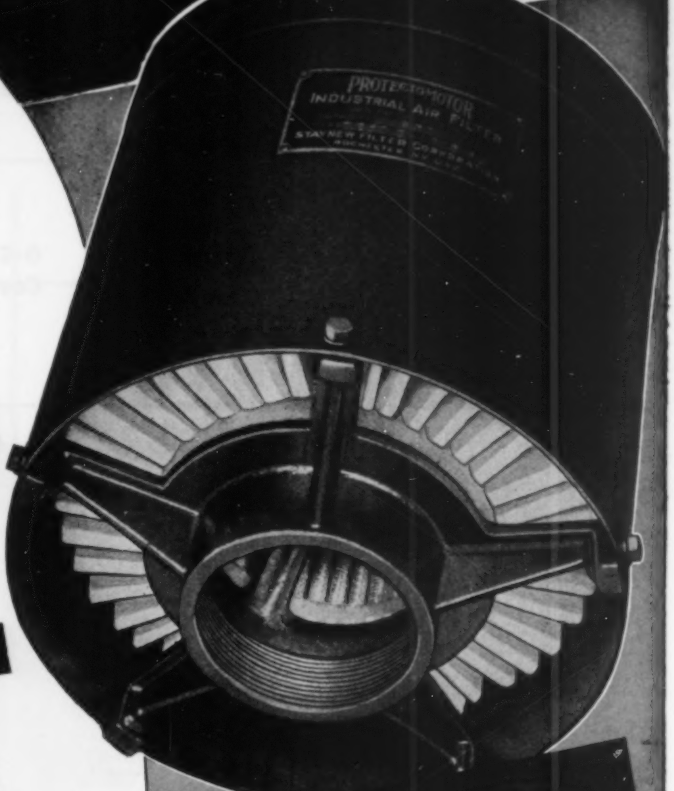
The Protectomotor is a masterpiece of simple, rugged construction. There are no moving parts, no reservoirs, no liquids. The extremely large active filtering area reduces cleaning to an absolute minimum for any given set of conditions. When required, cleaning is quickly and easily accomplished by vacuum, compressed air, or washing.

★ POSITIVE PROTECTION ★ ★ ★ ★

Inherent characteristics of the dry-type filtering media provide *positive* protection. Performance is *not* dependent upon periodic renewal of viscous coatings or other filter aids. Ideal for dust storm areas.

★ EFFICIENT AT HIGH OR LOW TEMPERATURES

As the filtering media used are of the dry-type, peak efficiency is maintained under all atmospheric conditions. There is no oil to evaporate at high temperatures or to congeal at low temperatures.



More than Half a Million Installations on Internal Combustion Engines and Compressors since 1920

Write for Catalog and Data Blank for Free Analysis of your Requirements

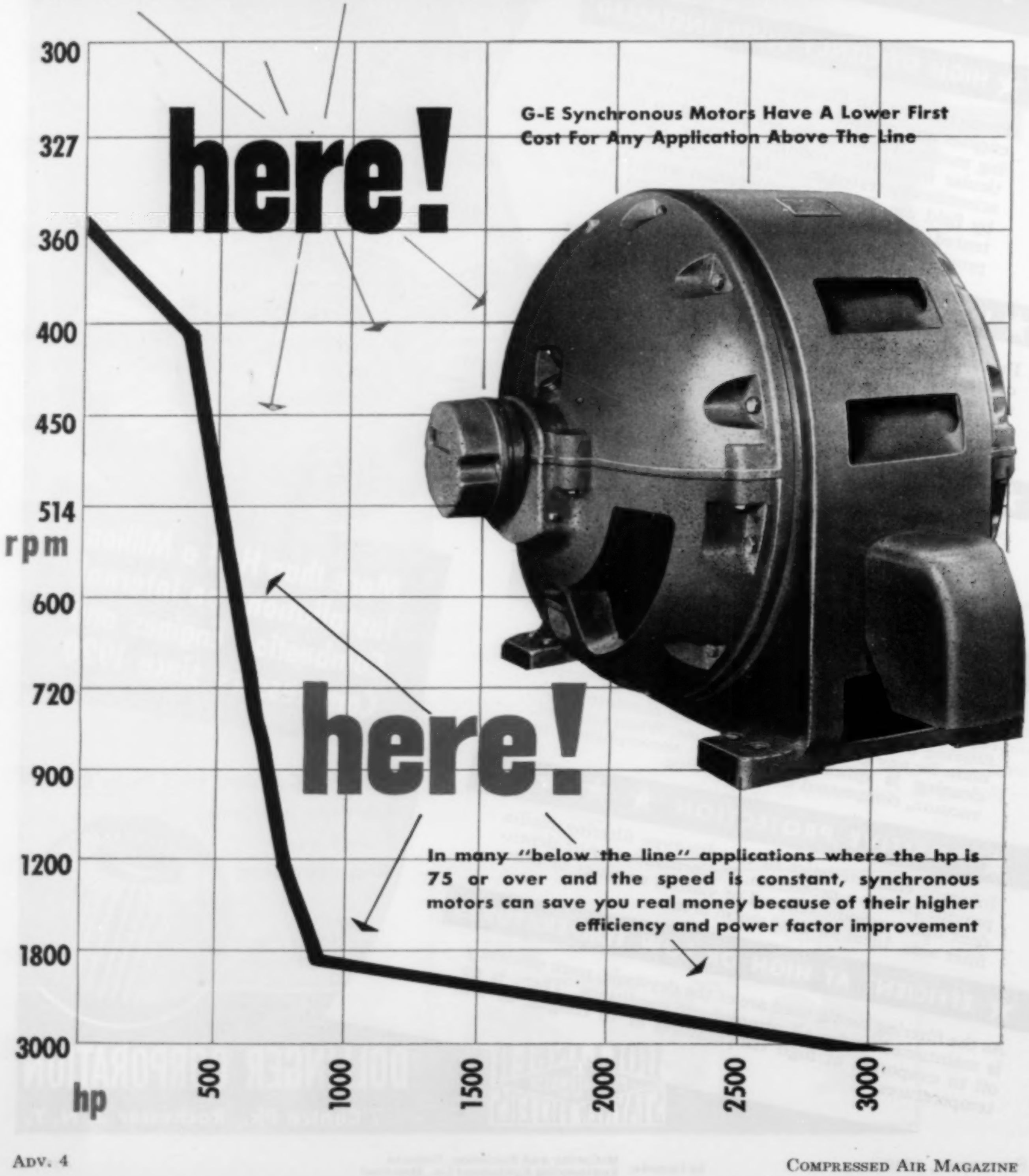
Radial Fin Construction

DOLLINGER
REG.
PROTECTOMOTOR
U.S. PAT. OFF.
STAYNEW FILTERS

DOLLINGER CORPORATION
7 Centre Pk., Rochester 3, N. Y.

In Canada: McCarthy and Robinson, Toronto
Engineering Equipment Co., Montreal

SAVE MONEY!



G-E Synchronous Motors Have A Lower First Cost For Any Application Above The Line

In many "below the line" applications where the hp is 75 or over and the speed is constant, synchronous motors can save you real money because of their higher efficiency and power factor improvement

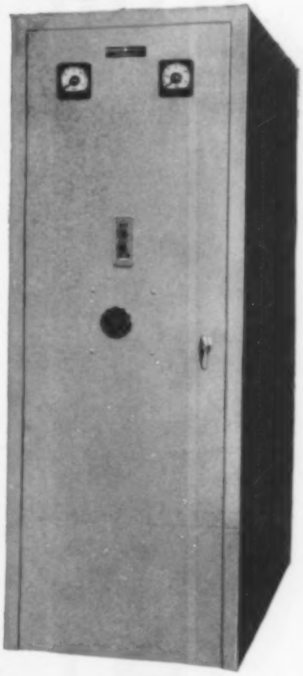
USE GENERAL ELECTRIC SYNCHRONOUS MOTORS

In their natural fields of application, synchronous motors have a *lower first cost* than any other kind of motor!

When you specify General Electric synchronous motors, you get unequalled application engineering by experts in the electrical problems of your industry. They make sure you get the right motor—the motor that will give you the greatest return on your investment.

For your next large, constant speed motor, ask your General Electric sales representative for the full story, and how you can take full advantage of the money saving features of G-E synchronous motors.

GET THE MOST FROM YOUR MOTOR WITH G-E CONTROL



New rotor field circuit prolongs life of your motor and equipment. Offers: precise synchronization (within half a cycle); constant protection without "babying" the motor; automatic and instant field removal at slip cycle.

This factory assembled and tested unit is your assurance of accurate motor performance regardless of type of G-E synchronous motor control you require — full-voltage magnetic, reduced-voltage magnetic, or reduced-voltage semi-magnetic. Standard, heavy duty components are panel mounted, enclosed in a compact, steel cabinet. Short-circuit protection with air-circuit breakers or high-voltage fuses is available. All parts easily accessible, little maintenance required, adjustments easy.

This is the quality control your synchronous motor needs for really efficient operation. It is specially engineered and built for years of service for your application. Write for the bulletin in the coupon.

Apparatus Dept., Sec. 770-4, General Electric Company
1 River Road, Schenectady 5, N. Y.

Gentlemen:
I would like more information on the advantages of synchronous motors. Please send me the indicated descriptive literature.

☐ GEA-529D ☐ GEA-5113 ☐ GEC-505

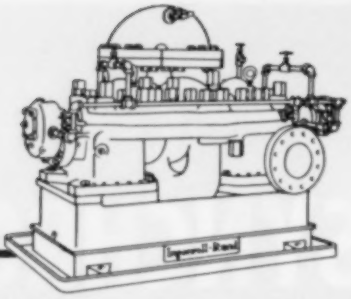
Name.................................... Company....................................

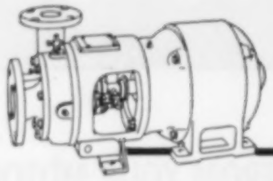
Street.................................... City....................................

State....................................

GENERAL ELECTRIC

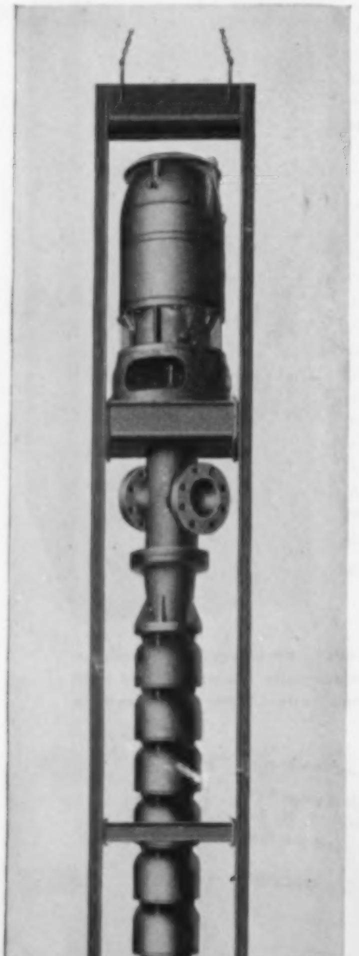
For Centralized





or Decentralized

Mine Drainage Systems



Vertical drainage or dewatering pump mounted on guide rails.

Keeping mines free from water is a tough job calling for thoroughly reliable pumps. That's why you'll find so many Ingersoll-Rand pumps serving in mines throughout the world.

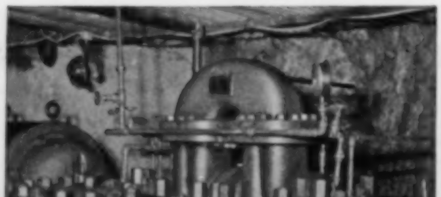
No matter what the type of drainage system—centralized, decentralized, or a combination of both—there's a correct size and type of I-R pump. They are constructed of the proper materials, corrosion resistant where necessary, to give the dependable trouble-free service you require.

Call upon the Ingersoll-Rand pump engineer near you to help you with your pump problems. He'll be glad to explain the important features of I-R mine pumps for dewatering and for the various other mine, mill, and smelter applications.

Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y.

373-10



Class RT 6-stage pump installed on the 17th level of a silver-lead mine.

Two sling-yoke mounted Motor-pumps being used for sinker service.

In machine shops, this air hose withstands heat, oil, abrasion and aging

...because tube
and cover are made of
Du Pont
NEOPRENE

Neoprene prevents breakdowns like this!

Valve chest and valve from an air tool have become clogged with particles of the tube, which has disintegrated from oil and heat.

Wherever this hose is used in shops or factories, you can count on it for long, dependable service life. For both inside and out, it's protected with tough, durable neoprene.

The neoprene tube won't disintegrate when exposed to hot lubricating oil. So no crumbled particles or chunks will be carried along to clog tools. And neoprene not only prevents clogging . . . but, because it retains its strength and toughness, it constantly protects the fabric reinforcement from oil, heat and moisture, which rot the fabric and lead to blow-outs.

Cover is made of neoprene, too. Even broiling sun, rain and winter temperatures won't make neoprene crack or soften when used outdoors. And indoors, a neoprene cover can take the punishment of yanking and dragging it over sharp edges and through shavings and filings. For neoprene withstands cutting, chipping, abrasion and constant contact with oil and grease.

So make sure of long service life . . . low replacement costs on the air hose you use. Ask your supplier for hose made with neoprene tube and cover. A neoprene hose stands up in the toughest service year after year.

E. I. du Pont de Nemours & Co. (Inc.), Rubber Chemicals Division Y-9, Wilmington 98, Delaware.

DU PONT
REG. U. S. PAT. OFF.

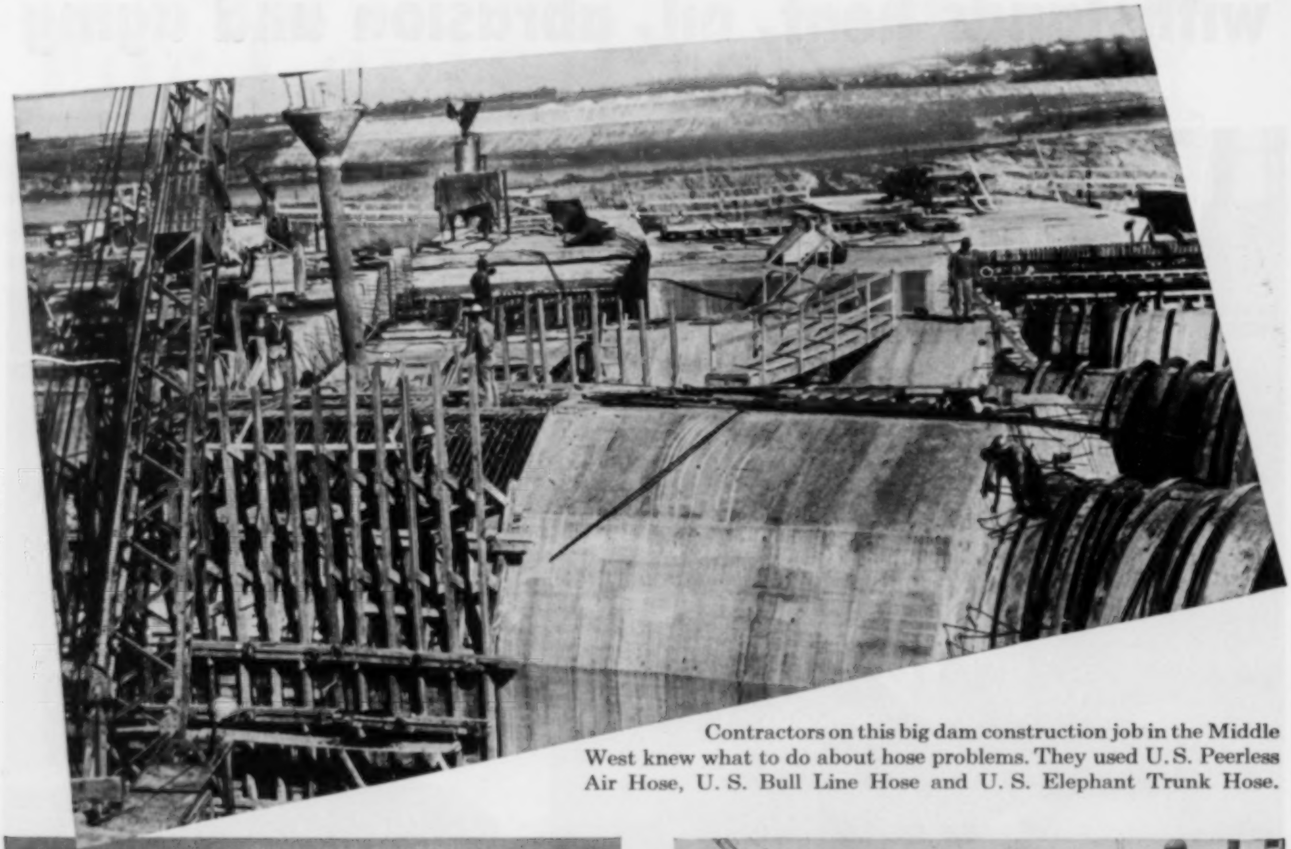
BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

SPECIFY HOSE MADE OF

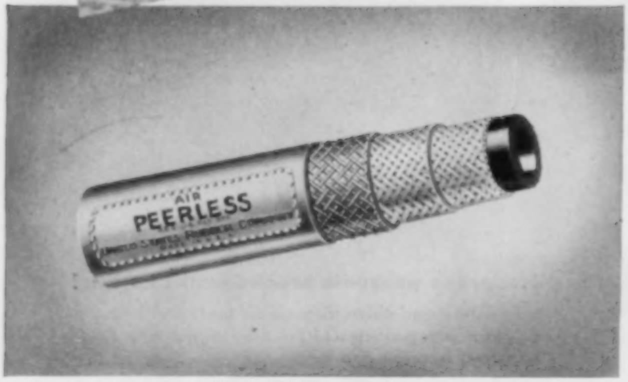
NEOPRENE

The rubber made by Du Pont

For rough, tough work—it's "U. S." Hose!



Contractors on this big dam construction job in the Middle West knew what to do about hose problems. They used U. S. Peerless Air Hose, U. S. Bull Line Hose and U. S. Elephant Trunk Hose.



U. S. PEERLESS AIR HOSE has oil-proof synthetic rubber lining, and a tough, flexible, brown rubber cover with a resilient surface workmen like to handle. Tube is specially compounded to take both hot and cold oil without swelling or flaking.

U. S. BULL LINE HOSE carrying air from compressor to manifold in air tool contract work. It is widely used for portable compressor work. Extra high pressure. Standard for tunnel contractors.

U. S. ELEPHANT TRUNK HOSE—wherever considerable quantities of concrete are poured, U. S. Elephant Trunk Hose provides an ideal method for dropping it speedily and efficiently into the proper spot.

Since the hose is flexible, it can easily be maneuvered and led into inaccessible places where concrete could not be dropped directly.

For more information about

U. S. ENGINEERED RUBBER PRODUCTS FOR THE CONTRACTOR

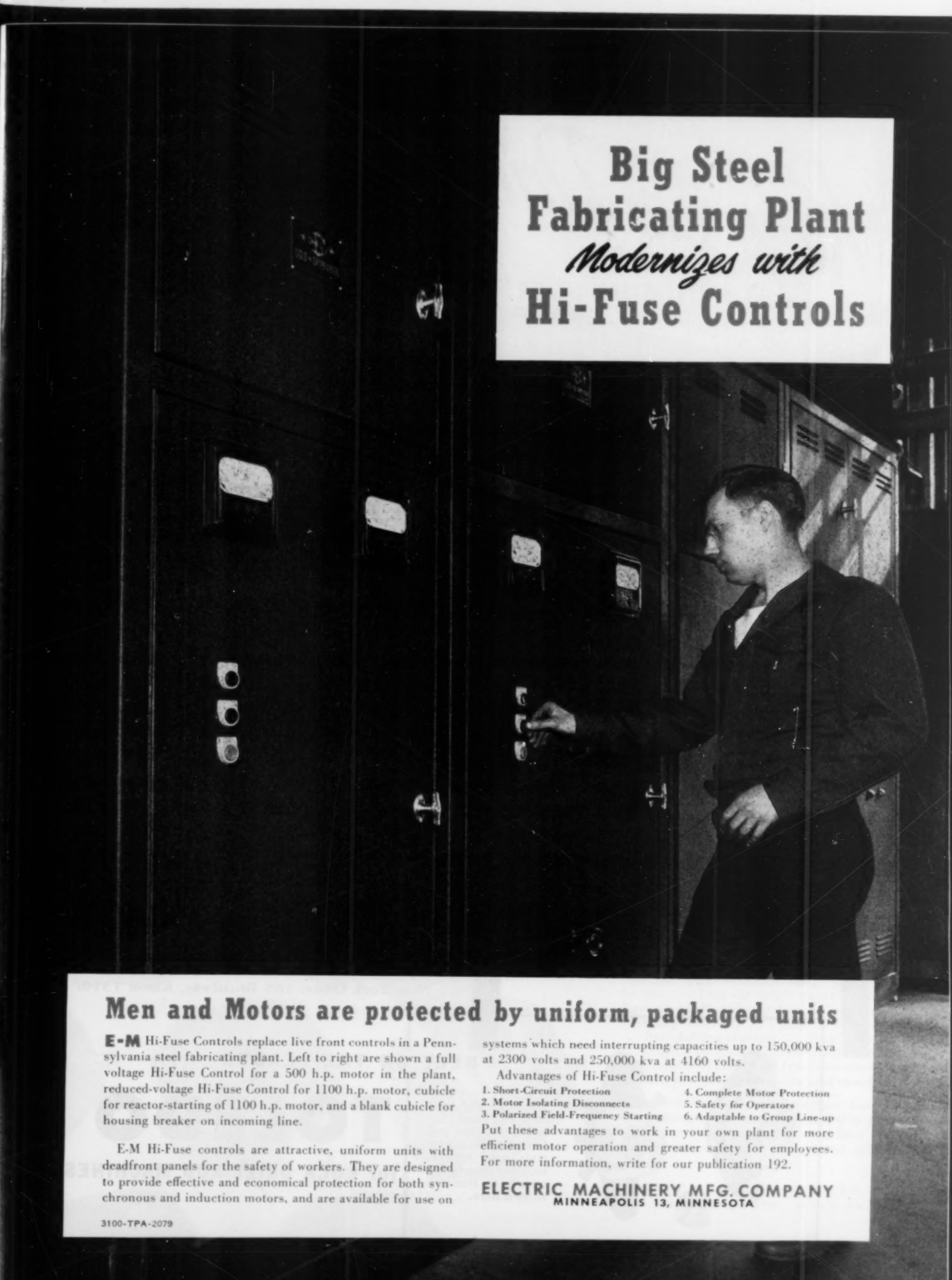
Hose • Belting • Gate Seals and Water Stops • Hydron

Write U. S. Rubber Co., Mechanical Goods Division, New York 20, N. Y.

PRODUCTS OF

U.S. RUBBER
SERVING THROUGH SCIENCE

UNITED STATES
RUBBER COMPANY



Big Steel Fabricating Plant *Modernizes with* Hi-Fuse Controls

Men and Motors are protected by uniform, packaged units

E-M Hi-Fuse Controls replace live front controls in a Pennsylvania steel fabricating plant. Left to right are shown a full voltage Hi-Fuse Control for a 500 h.p. motor in the plant, reduced-voltage Hi-Fuse Control for 1100 h.p. motor, cubicle for reactor-starting of 1100 h.p. motor, and a blank cubicle for housing breaker on incoming line.

E-M Hi-Fuse controls are attractive, uniform units with deadfront panels for the safety of workers. They are designed to provide effective and economical protection for both synchronous and induction motors, and are available for use on systems which need interrupting capacities up to 150,000 kva at 2300 volts and 250,000 kva at 4160 volts.

Advantages of Hi-Fuse Control include:

1. **Short-Circuit Protection**
2. **Motor Isolating Disconnects**
3. **Polarized Field-Frequency Starting**
4. **Complete Motor Protection**
5. **Safety for Operators**
6. **Adaptable to Group Line-up**

Put these advantages to work in your own plant for more efficient motor operation and greater safety for employees. For more information, write for our publication 192.

ELECTRIC MACHINERY MFG. COMPANY
MINNEAPOLIS 13, MINNESOTA

3100-TPA-2079

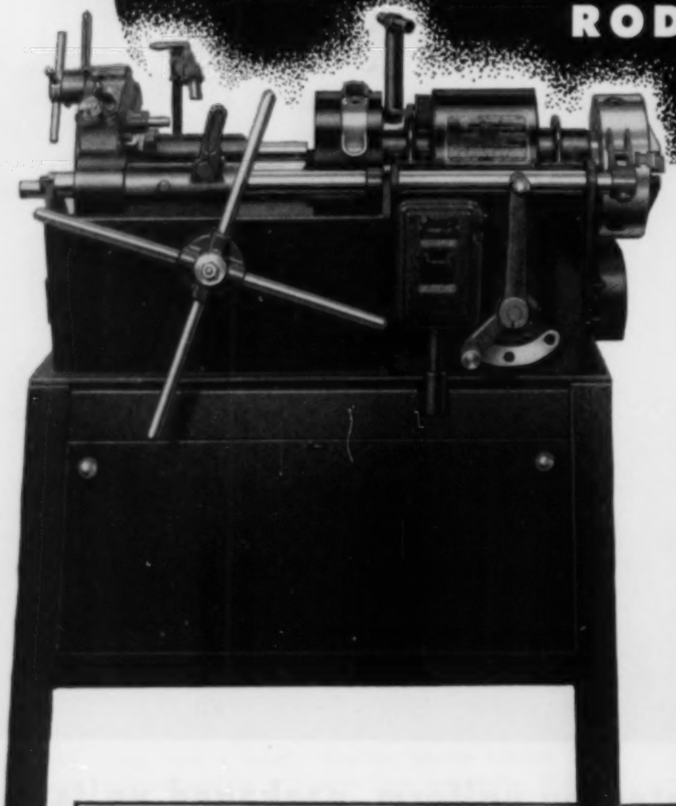
Keep 'em Drilling

AT MINIMUM COST!

thread your drill rod

ON THE JOB

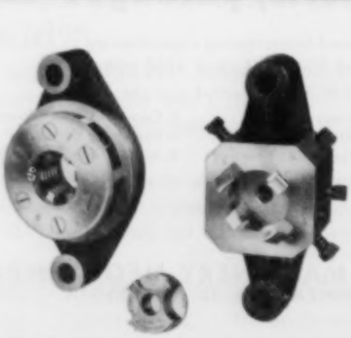
with a TOLEDO ROCK DRILL ROD MACHINE



Keep your drill rod in service *at minimum cost*—use a TOLEDO 2″ High Speed Rock Drill Machine! Will thread new or re-thread broken drill rod *right on the job*—at a fraction of the cost of a new rod. Reduces downtime and expense.

Can be tooled to produce Ingersoll-Rand and Timken threads. After rod is annealed the Toledo Machine will turn to size, thread and face off end of rod to a perfect fit for detachable bits.

Sturdy, proven design . . . simple operation. Multiple disc clutch. Chain drive, fully enclosed. Two chucks. Round renewable ways. All steel construction. Centrifugal oil pump. All gears run in oil bath. Segmental dies and tools can be reground for additional service when dull. Send today for complete details. The Toledo Pipe Threading Machine Co., Toledo Ohio. New York Office: 165 Broadway, Room 1310.



Die head and dies, tool box and cutters for turning and forming Timken rods, and special stop for setting the cutters to size are shown here.

RELY ON THE LEADER

TOLEDO

for ROCK DRILL ROD MACHINES

Yes—
they do look alike!

BUT...
Electrically
they may be all special
. . . and all DIFFERENT

Many different electrical characteristics can be supplied in the same mechanical enclosures — viz.:

Zero speed stalled torque . . . *Triple horsepower* . . . Multiple torque . . . *Matched speed* . . . Rapid reversing . . . *Plugging duty* . . . Regenerative braking . . . *Controlled torque* . . . Multi-speed . . . *Synchronous induction* . . . Special high efficiencies . . . *Special power factor* . . . Low or high starting torque . . . *Low or high pullout torque* . . . Special low starting current . . . *Low temperature rise* . . . Special insulation . . . *Single, 2 or 3 phase* . . . High and non-standard voltages . . . *High and non-standard frequencies* . . . And countless other variations and combinations.

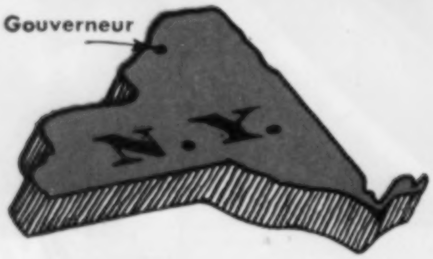
For almost half a century we have been designing and building motors especially suited to the exacting requirements of industry. If you have an electric motor problem, consult our nearest office.

★

THE LOUIS ALLIS CO.
MILWAUKEE 7, WISCONSIN

RockerShovels at work for

LOOMIS TALC



An Eimco Model 12B loading talc at Loomis Talc Mine

Eimco RockerShovels working deep in the earth are helping produce Gouverneur Fibrous Talc, a very old, rare and valuable ingredient in some of our common important everyday products such as paint, ceramics, paper, rubber and many other items.

The W. H. Loomis Talc Corporation, producers of this material, have, after numerous tests, standardized on Eimco RockerShovels for loading the talc into mine cars for transportation to the surface.

RockerShovels are standard equipment wherever mining is being done — because RockerShovels stay underground longer without coming up for repairs; provide greater protection for the opperator; and, load more tons per shift, day in and day out, than any other comparable machine.

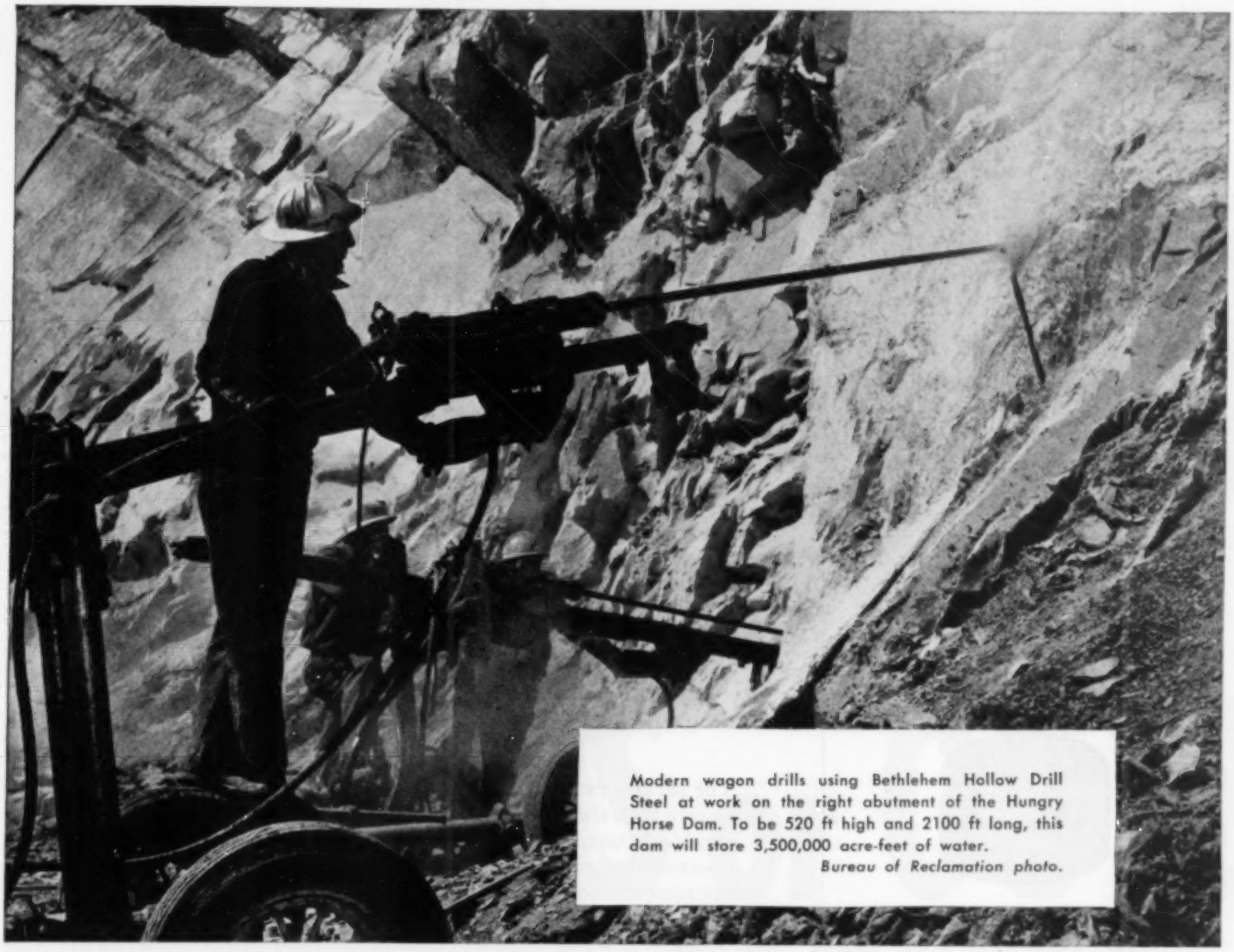
RockerShovels are better on every count — write for more information on any of the 3 underground models — Model 12B for 1 ton per minute; Model 21 for 2 to 3 tons per minute and Model 40 for 4 to 5 tons per minute.

EIMCO

THE EIMCO CORPORATION

The World's Largest Manufacturers of Underground Rock Loading Machines

EXECUTIVE OFFICES AND FACTORIES — SALT LAKE CITY 8, UTAH, U. S. A.
BRANCHES: NEW YORK, CHICAGO, BIRMINGHAM, EL PASO, SACRAMENTO, MANILA
AFFILIATED COMPANIES: SOCIETE EIMCO, PARIS, FRANCE
EIMCO (GREAT BRITAIN) LTD., LEEDS 12, ENGLAND
AGENTS IN ALL PRINCIPAL CITIES THROUGHOUT THE WORLD



Modern wagon drills using Bethlehem Hollow Drill Steel at work on the right abutment of the Hungry Horse Dam. To be 520 ft high and 2100 ft long, this dam will store 3,500,000 acre-feet of water.
Bureau of Reclamation photo.

Drilling the Way for the Hungry Horse

More than 1,000,000 cu yds of rock is being drilled, blasted and excavated from the river channel and canyon walls to make way for the gigantic Hungry Horse Dam. The fourth largest of all concrete dams, Hungry Horse will impound the Flathead River in northwestern Montana for irrigation and power purposes.

Bethlehem Hollow Drill Steel used with modern drilling equipment is helping General-Shea-Morrison Company, the prime contractor, keep on schedule despite the difficulties brought on by one of the worst winters in Montana history. Used on practically all of the Bureau of Reclamation projects, Bethlehem Hollow has a reputation among hard-rock men everywhere as a tough, fatigue-resisting drill steel.

Bethlehem Hollow is always uniform in its properties, for its hardenability is closely controlled . . . the center hole is smooth and true . . . its wide quenching-range means easy heat-treating . . . it is equally suitable for forged-on or detachable bits.

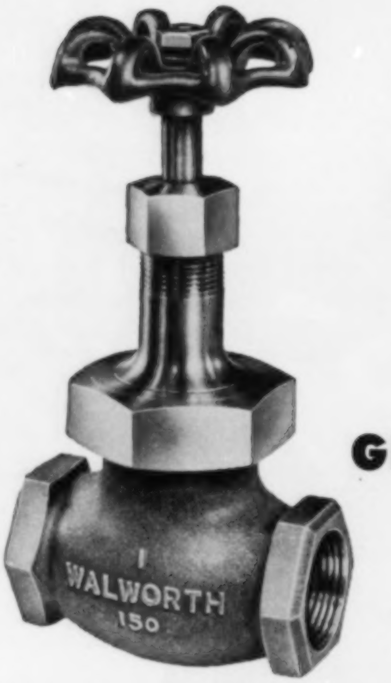
There's no better cure for drill-steel problems than having this "Old Reliable" on the job.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM
STEEL

BETHLEHEM HOLLOW DRILL STEEL

WALWORTH



IMPROVED No. 95 BRONZE GLOBE VALVE

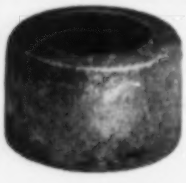
also available in Angle Type (No. 96)

The service ratings of the Walworth No. 95 are 150 pounds per square inch steam at 500F, and 300 pounds per square inch non-shock cold water, oil, and gas. In the manufacture of this quality bronze valve, more than 47 gages are used in machining parts to micrometric accuracy, thus insuring interchangeability of parts. For further information see your local Walworth distributor, or write: Walworth Company, 60 East 42nd St., New York 17, N. Y.

note these 7 Great Features

Toothed Lock Washer: Prevents loss of stem nut due to vibration, thereby holding the handwheel securely.

Newly Designed Handwheel: Air-cooled, finger grip handwheel affords sure grip even with greasy gloves.



Improved Packing: Molded packing of lubricated asbestos reinforced with copper wire. Suitable for practically every service. Valves can be repacked under pressure.

Hexagonal Union Bonnet Connection: Eliminates any chance of distortion or leakage even though valve is repeatedly taken apart and assembled.

New Cylindrical Disc Holder: The design of the top portion of the disc holder keeps the disc accurately guided under all operating conditions.

Renewable Asbestos Disc: This disc is suitable for steam up to 500F and is resistant to oil, gasoline, and many chemicals at atmospheric temperatures. Discs for special services are available.

Extra Strong Body: Made of Composition M (ASTM B61) bronze thick enough to provide a high safety factor. Valves undergo hydrostatic shell test of 450 psi.

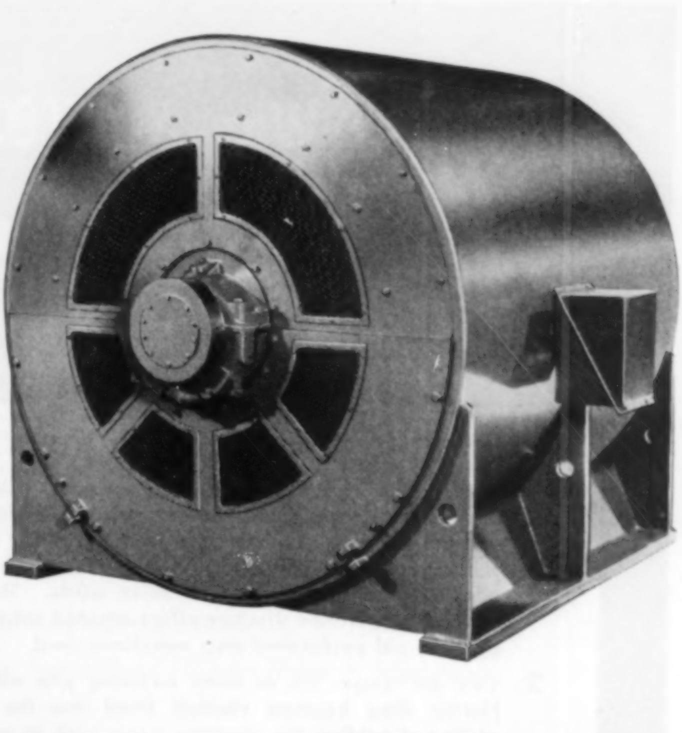
WALWORTH

valves and fittings

60 EAST 42nd STREET NEW YORK 17, N. Y.

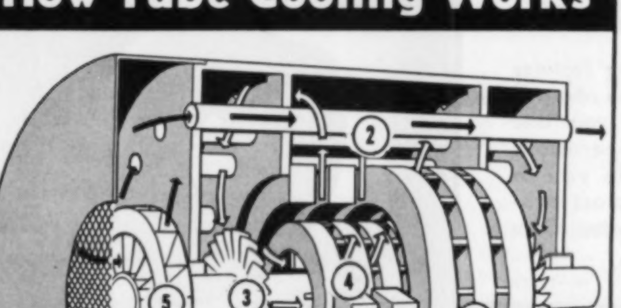
DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

TUBE-TYPE
TOTALLY-ENCLOSED FAN-COOLED MOTORS!



INSTALL INDOORS or OUT!

How Tube Cooling Works



Stator core (1) is surrounded by tubes (2). Internal fans (3) circulate air through ducts (4) in rotor and stator and around tubes, transferring heat to tubes.

External fan (5) drives outside air through tubes, removing heat and keeping tubes clean. All electrical parts are enclosed. Dirt cannot enter.

- ☛ **Dirt-proof and corrosion-resistant**
- ☛ **Heat exchanger is practically *self-cleaning***
- ☛ **Simple self-contained cooling system—sizes from 75 to several thousand horsepower**

WHEREVER DUST, DIRT, fly ash, rain and snow, smoke, or corroding fumes keep motor maintenance costs high, this Allis-Chalmers tube-type motor will cut maintenance sharply.

All electrical parts—including stator core—are enclosed. Simple heat transfer system keeps temperatures well within rated limits. Cleaning is rarely needed because air passages are unrestricted. Air flow through the straight tubes removes foreign matter.

Important savings have been proved in three years of field operation. Sizes from 75 hp and up. Also explosion-proof designs. For complete information, outline your requirements to your A-C Sales Office, or write for Bulletins 05B7150 and 51R7149.

A-2610

ALLIS-CHALMERS, 1000A SO. 70 ST.
MILWAUKEE, WIS.

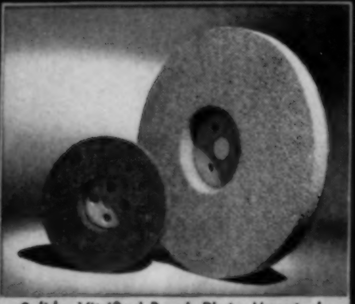
ALLIS-CHALMERS

4 Reasons Why NORTON *Vitrified* Discs Can Cut Your Grinding Costs—

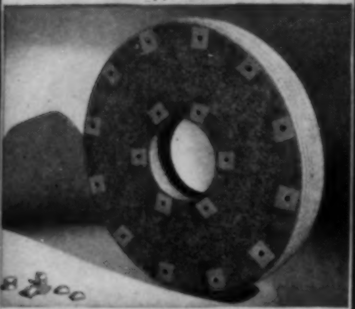
1. You get a faster, cooler cutting action on many foundry surfacing jobs with Norton Vitrified "P" or porous type discs, because the grain spacing in these discs is accurately controlled for extra chip clearance and the cutting action is uniform from periphery to hole. This makes them particularly well-suited for handling alloy steel and other heat-sensitive parts. Their scientifically controlled structure offers decided advantages over the old perforated discs sometimes used.
2. You get longer life on many surfacing jobs with these Norton discs because vitrified bond has the unique ability of holding the abrasive grain until its complete cutting life has been utilized, and then releasing the grain when it commences to dull. This eliminates the need for frequent dressing.
3. You eliminate aging and storing problems often encountered with magnesite bonded discs when you use Norton Vitrified Discs, for vitrified bond is stable and mature. These Norton discs are ready for use immediately upon delivery or may be stored until needed as the grinding properties will remain unchanged.
4. You save on initial expense, for vitrified bonded discs in sizes up to 30″ in diameter cost considerably less than resinoid discs.

Why not take advantage of these cost-cutting features offered by Norton Vitrified Discs? Your Norton abrasive engineer or distributor will be glad to study your disc grinding operations and to help you to select the most economical Norton Discs for each job.

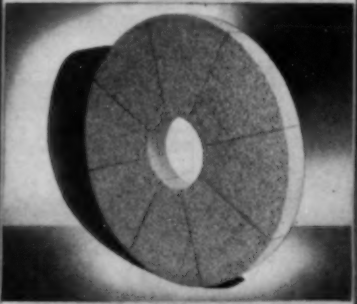
W—1255A



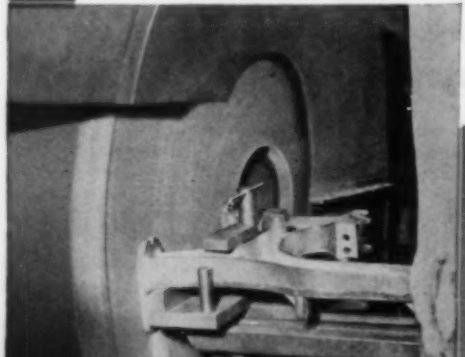
Solid—Vitrified Bond, Plate Mounted, Type PC



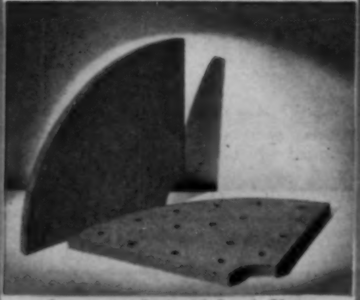
Solid—Vitrified Bond, Inserted Nut, Type N



Segmental—Vitrified Bond, Plate Mounted, Type PN



Segmental—Vitrified Bond, Inserted Nut, Type N



Segments—Resinoid Bond, Plate Mounted, Type PC

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ON THE COVER

IN THE Mexican state of Durango, about 90 air miles inland from Mazatlan, Gulf of California seaport, is a 300-year-old mining district. Present production is centered at Tayoltita. To get there, you must either fly over intervening mountains or spend many hours on a mule's back. The latter portion of the air trip requires descending into the yawning canyon of the Piaxla River and following its twisting course into the landing field. There are always treacherous air currents to contend with, but as they are least troublesome during one early morning hour out of the 24, the flight to and from Tayoltita is made at that time. Even seasoned air travelers experience a thrill in coming down on the none-too-commodious landing strip, which was built by evening up the ground surface with old mill tailings. The field is inclined and planes land in the uphill direction to gain the advantage of the braking effect. Our cover shows how the strip looks from an approaching plane.

●

IN THIS ISSUE

THE early settlers thought the principal wealth of California's Feather River lay in its gold-bearing gravels, which they combed rather thoroughly and with good but short-lived results. The present generation is finding greater and more lasting value in the stream's capacity to generate power. When a current construction program is completed, Pacific Gas & Electric Company will have harnessed the river for a total of 514,000 horsepower. The work involves 10½ miles of tunneling, which is being carried out by three contractors. Page 218.

●

LACKING modern excavating and earth-moving equipment, pioneer railroad builders laid out routes in mountainous country with an eye to saving time, effort, and money. Many of the lines were consequently winding and steep. Since then, with traffic and train speeds continually on the increase, the carriers have gradually rebuilt these sections to reduce curvature and gradients. The Norfolk and Western Railway now has in hand a job of this kind in West Virginia. Its central feature, the New Elkhorn Tunnel, is described in an article that starts on page 224.

●

MOST of us will never make an air trip to Tayoltita, secluded Mexican mining town, but we can do it vicariously through the article that starts on page 230. Mining men will derive additional interest from the account of how Tayoltitans extract silver from the Sierra Madre lodes.

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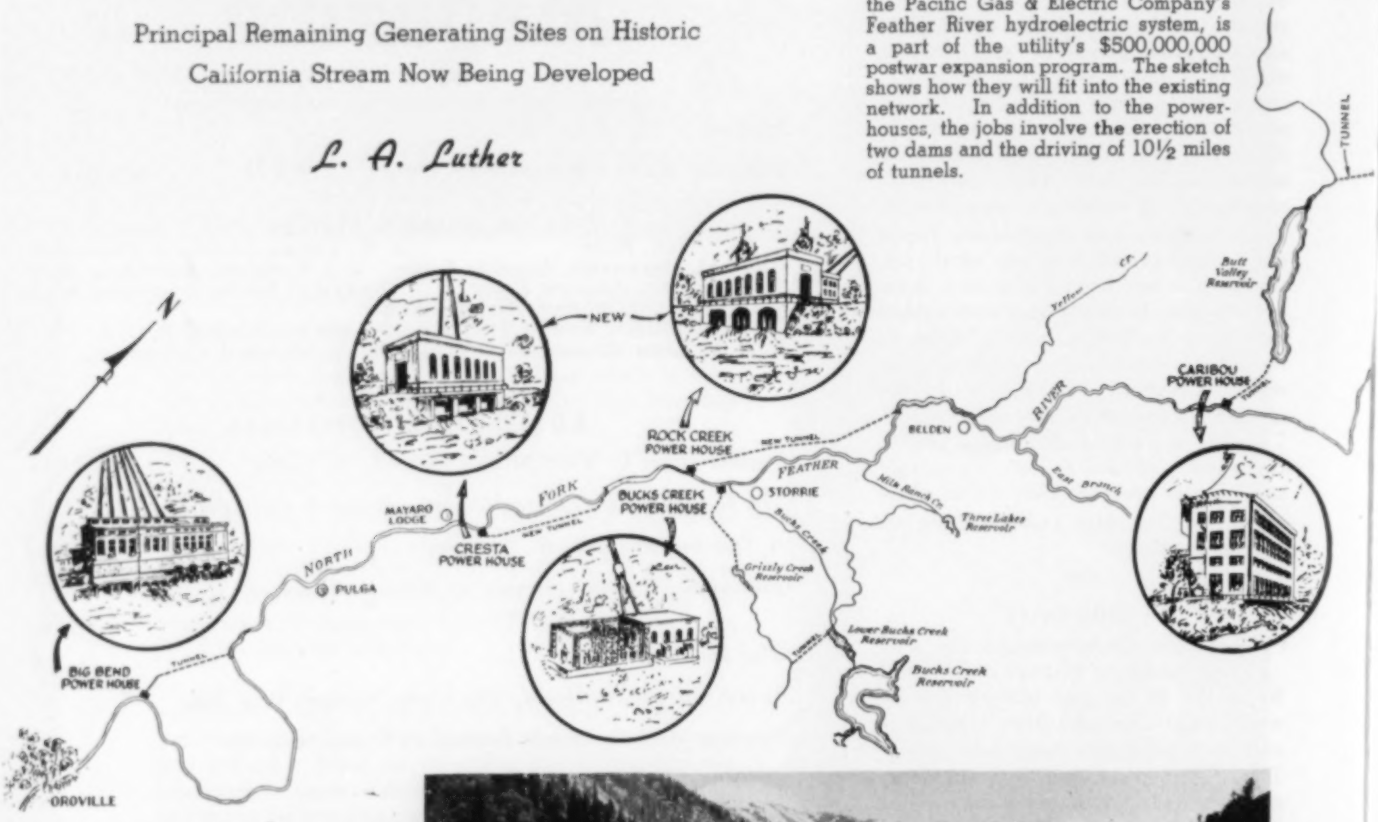
Feather River to Yield More Power

Principal Remaining Generating Sites on Historic California Stream Now Being Developed

L. A. Luther

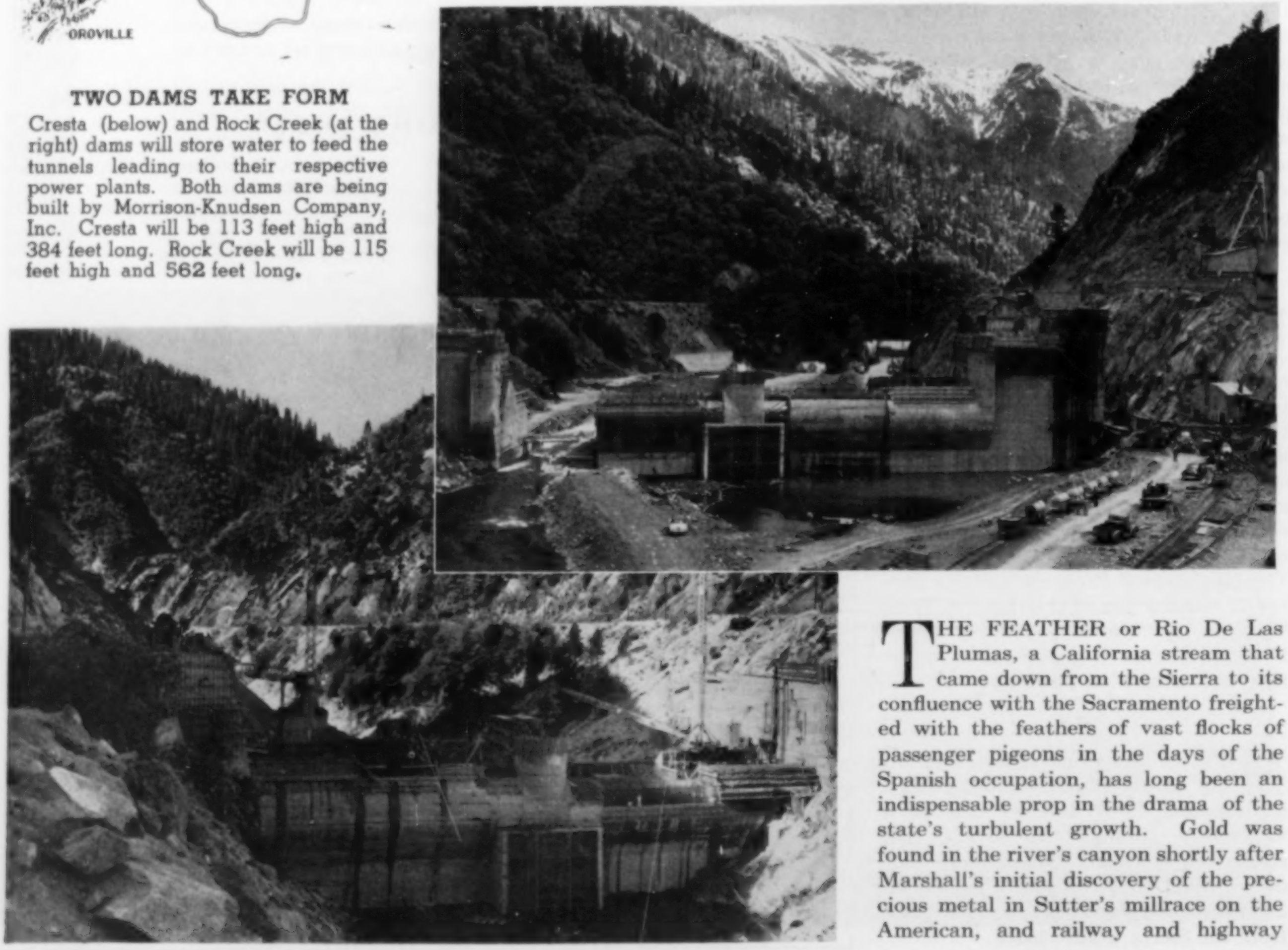
LOCATION DRAWING

Construction of the Cresta and Rock Creek power plants, which will add 270,000 horsepower to the capacity of the Pacific Gas & Electric Company's Feather River hydroelectric system, is a part of the utility's $500,000,000 postwar expansion program. The sketch shows how they will fit into the existing network. In addition to the powerhouses, the jobs involve the erection of two dams and the driving of 10½ miles of tunnels.


N
NEW
TUNNEL
Butt Valley Reservoir
Yellow Cr.
CARIBOU POWER HOUSE
ROCK CREEK POWER HOUSE
NEW TUNNEL
BELDEN
RIVER
FEATHER
East Branch
Milk Ranch Cr.
Three Lakes Reservoir
STORRIE
BUCKS CREEK POWER HOUSE
Bucks Creek
Grizzly Creek Reservoir
Lower Bucks Creek Reservoir
TUNNEL
Bucks Creek Reservoir
MAYARO LODGE
FORK
NEW TUNNEL
CRESTA POWER HOUSE
NORTH
PULGA
BIG BEND POWER HOUSE
TUNNEL
OROVILLE

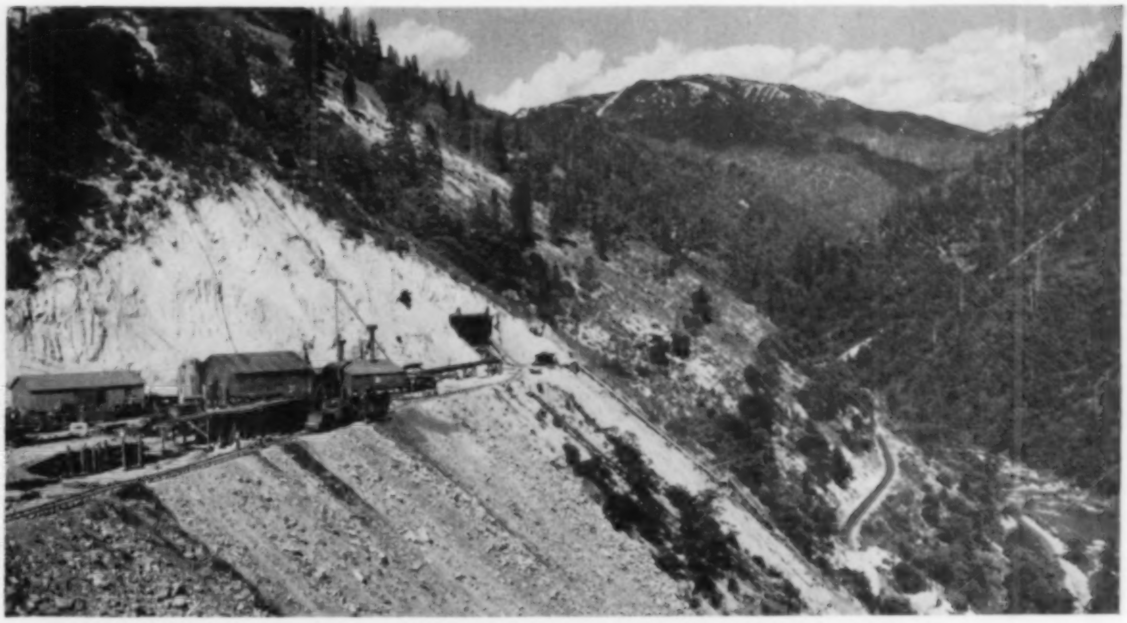
TWO DAMS TAKE FORM

Cresta (below) and Rock Creek (at the right) dams will store water to feed the tunnels leading to their respective power plants. Both dams are being built by Morrison-Knudsen Company, Inc. Cresta will be 113 feet high and 384 feet long. Rock Creek will be 115 feet high and 562 feet long.



THE FEATHER or Rio De Las Plumas, a California stream that came down from the Sierra to its confluence with the Sacramento freighted with the feathers of vast flocks of passenger pigeons in the days of the Spanish occupation, has long been an indispensable prop in the drama of the state's turbulent growth. Gold was found in the river's canyon shortly after Marshall's initial discovery of the precious metal in Sutter's millrace on the American, and railway and highway

Lake
Almanor



TUNNEL CAMP AND PORTAL

Service buildings of Walsh Construction Company and, beyond them, the lower portal of Rock Creek Tunnel. On the right are the Western Pacific Railroad tracks and the Feather River.

travelers can still trace well-defined pack trails of the Forty-niners along its precipitous walls. The transient boom of the gold rush saw sizable cities flourish at points now almost deserted; but other values of economic importance obtained from the Feather through man's initiative and labor have proved more rewarding than its fabulous Rich Bar or other noted concentrations of gold.

Among the river's more enduring values is hydroelectric power, a steadily swelling "poke" enriching the lives of dwellers in the San Francisco Bay cities, in inland towns, and on ranches. The Pacific Gas & Electric Company, a utility serving central and northern California, is driving more than 10 miles of tunnels through granite temporarily to divert and deliver water to two new powerhouses, after which it is returned to the stream. The company is now generating an aggregate of 244,000 hp. at three sites in this watershed; and when the present program is completed, the capacity of its Feather River System will total 514,000 hp.

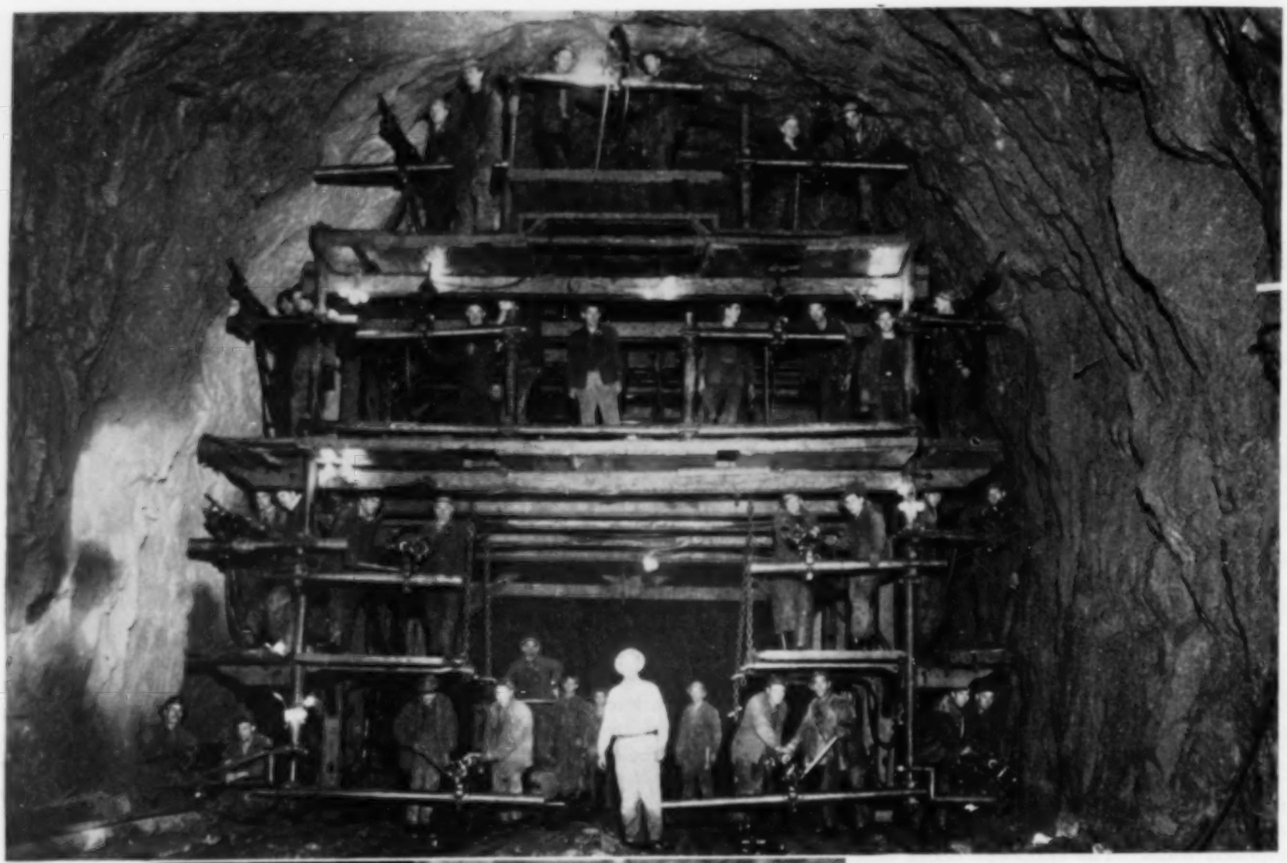
It is cause for comment that electric current is one of the few universally used commodities that has reduced rather than skyrocketed in price, a boon to householders striving to make shrinking dollars cover swelling budgets. With heavy taxation and high labor and material costs, this has necessitated careful planning on the part of utility managements. Every advantage has had to be taken of technological advances, and it has required courageous financing to expand sufficiently to keep pace with increasing domestic and industrial demands. This applies especially to the West Coast, where Pacific Gas & Electric expects to add two million horsepower to its hydroelectric and steam generating capacity by 1951. The company will spend some 500 million dollars on a postwar program delayed by wartime scarcities.

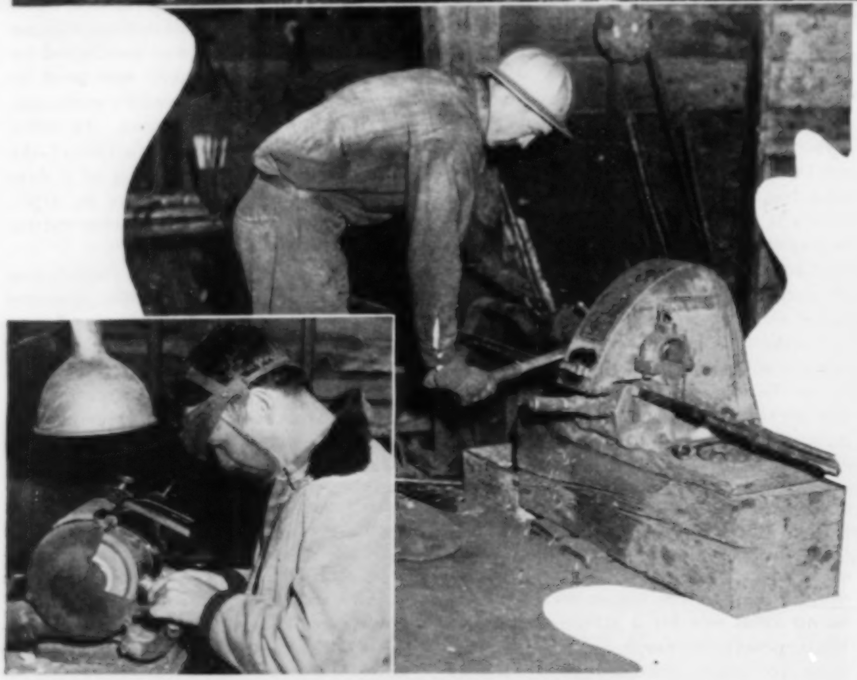
This big project, which includes the building of 506 miles of the country's largest natural-gas pipe line, is being financed from earnings and by the sale of bonds and stock to thousands of small subscribers, a large percentage of whom are customers of the utility. The concern has grown with the communities which it has served since their modest beginnings, and it is interesting to note that its 1948 dividends amounted to but 59 percent of the aggregate municipal, state, and federal taxes paid that year.

Pacific Gas & Electric's earliest association with the hydroelectric resources of the Feather River came about casually at the turn of the century through Julius M. Howells, a cousin of the famed critic William Dean Howells and founder of a predecessor firm, Western Power. While making geological surveys in the area for Harvard's Prof. Alexander Agassiz, Howells noted that Big Meadows, a great level park at an altitude of 4500 feet in the upper Sierra, would be an ideal site for a storage reservoir. Waterpower development was at that time an infant industry, but Howells subsequently became active in forming Western Power, later Great Western Power. The financial status of the company was still in a critical stage in 1906 when the San Francisco earthquake not only destroyed most of the city but also shook the confidence of investors in all California undertakings.

Another Easterner, Dr. R. V. Pierce, had made an unintentional contribution to the Feather River power project by investing his patent-medicine fortune in the Big Bend Tunnel & Mining Company, a placering venture at a big bend in the stream some 16 miles above Oroville. A 3-mile diversion tunnel was driven to connect the ends of the 10-mile loop and leave the river bed open for placer mining. The ambitious scheme failed, and the tunnel was purchased by Great Western, enlarged, and used to carry water to the Big Bend Powerhouse, the first built in the canyon. In 1913, Big Meadows was transformed into Lake Almanor by the construction of a dam which, through an addition in 1927, formed a reservoir with a storage capacity of 1,308,000 acre-feet.

The initial Big Bend plant, which was placed in commission in 1908, operates under a static head of 465 feet and now has an installed generator capacity of 87,131 hp. A second one—Caribou—is located some 50 miles upstream from Big Bend. It was put in service in 1921 and produces 89,369 hp., the static head being 1149 feet. The water for it, and for the entire Feather River development except Bucks Powerhouse, comes from Lake Almanor. It is carried through a 2-mile tunnel to Butt Valley Reservoir, with 50,000 acre-foot storage, from which another bore, 9200 feet long, conveys it to the head of the penstock pipelines. The newest of the three plants now drawing on the Feather River watershed is the Bucks station at the confluence of Bucks Creek and the North Fork of the Feather about 25 miles above Las Plumas. Put in operation in 1928, it develops 67,024 hp. and takes water from Bucks Creek Reservoir which is in the upper reaches of the stream and has a capacity of 104,000 acre-feet. Twin penstocks feed it to the turbines under a head of 2561 feet, the highest of any





TUNNEL DRILL CARRIAGE AND ACCESSORIES

One of three drill carriages used by T. E. Connolly, Inc., for driving thé 27-foot wide Cresta Tunnel is shown at the top. It spans two mine-car tracks and carries 15 DA-30 drifter drills that put in from 120 to 140 holes per 9-foot round. Carset bits of 1½-inch gauge average more than 200 feet of hole each before being discarded and have drilled out a round in 54 minutes. The bits are reground from one to five times, this being done by hand-holding them as illustrated in the bottom picture. The endurance of the bits greatly reduces the number of changes required and, consequently, only 75 drill rods are used per round as against an estimated 600 if steel bits were employed. The alloy steel for the rods is cut to desired lengths by a No. 500 cut-off wheel (center picture).

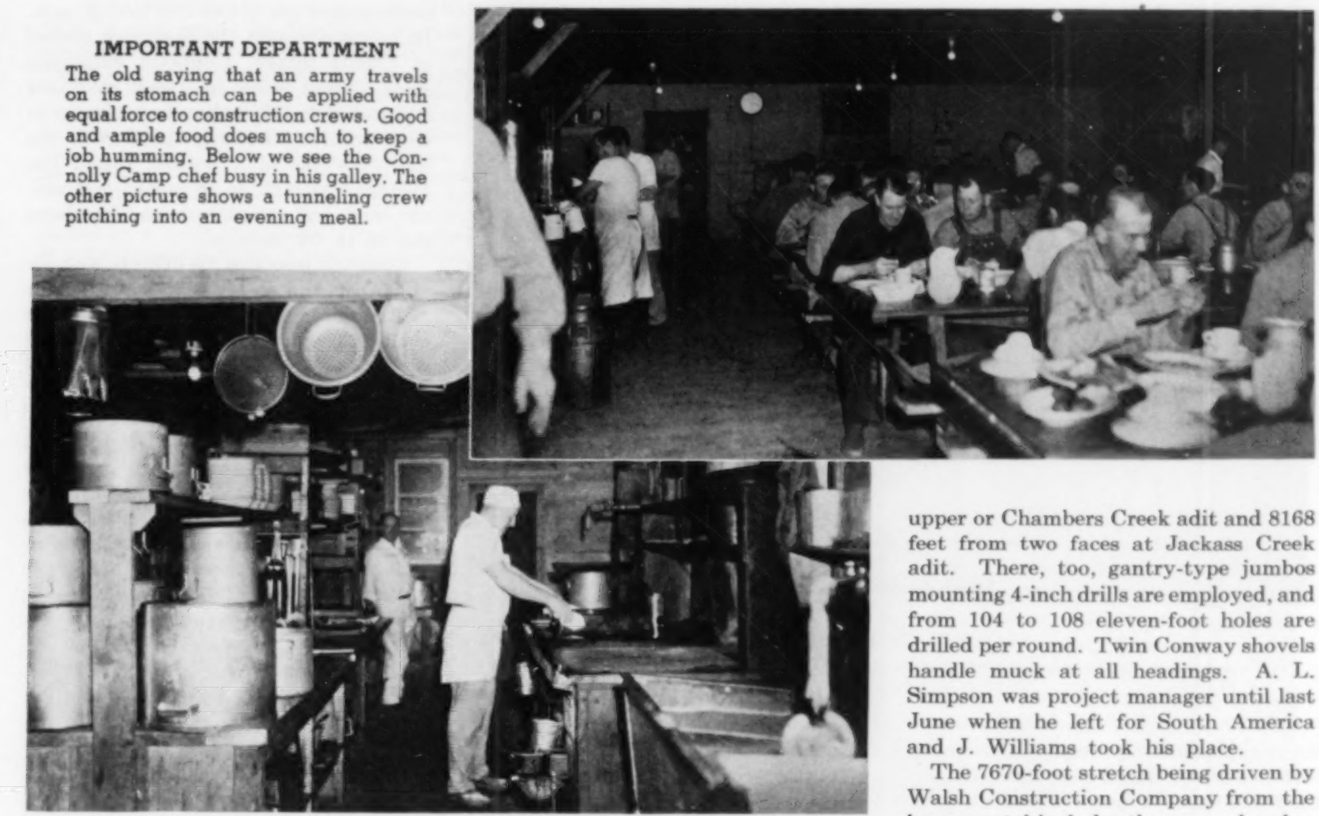
hydroelectric station in the country.

The two new projects under construction on the Feather by Pacific Gas & Electric are located between the Big Bend and Caribou plants and necessitate excavating a total of 10½ miles of the largest-diameter hard-rock tunnel ever undertaken by the utility. Beginning at the upper site, Rock Creek, water will be diverted from the river about 2 miles below Belden by a concrete, gravity-type dam 562 feet long at the crest and rising 115 feet above the stream bed. The 2300-acre-foot reservoir created will be connected with Rock Creek Powerhouse by 34,115 feet of horseshoe-shaped tunnel 25 feet in diameter. It is being driven in granite on a 0.3 percent grade and will have a maximum capacity of 3000 cubic feet per second.

A surge chamber, which will serve to control surges caused by rapid opening and closing of the turbine gates, is being built underground above the tunnel and 919 feet in from the portal. It is 55 feet in diameter, 143 feet high, and will be lined with reinforced Gunite. Two vertical turbines in a concrete structure will operate under a head of 535 feet and have a combined capacity of 169,000 hp. They will be connected with the tunnel by twin steel pipe lines passing through a bore driven under the Western Pacific Railroad and a state highway. Each will be 930 feet long and have a diameter of 12 feet at the top and 10½ feet at the turbines.

IMPORTANT DEPARTMENT

The old saying that an army travels on its stomach can be applied with equal force to construction crews. Good and ample food does much to keep a job humming. Below we see the Connolly Camp chef busy in his galley. The other picture shows a tunneling crew pitching into an evening meal.



Cresta, the other new plant, will be served by a forebay formed by constructing a diversion dam at a point in the river about 11 miles below Belden. The dam will reach to a height of 113 feet above the stream bed and be 384 feet long at the crest. The water will flow at a maximum volume of 3500 cubic feet per second through a 27-foot-diameter horseshoe-shaped tunnel, 20,900 feet long and on a 0.23 percent grade, and through 220 feet of conduit across Grizzly Creek.

A surge chamber, similar to that for the Rock Creek development except that the top is not underground, is being built on the mountain slope to one side of the main tunnel line and 872 feet in from the portal. It is 46 feet in diameter, 135 feet high, and connected to the tunnel by a 16-foot-diameter lateral 170 feet long. Twin penstocks, each 12 feet in diameter and 759 feet long, will carry the water under a head of 290 feet to two turbines that are to be housed in a concrete structure and have a capacity of 101,000 hp. Transformer banks at both powerhouses will take current from the generators at 11,500 volts and step it up to 220,000 volts for transmission over the company's interconnected system.

Drilling of the 34,115 feet of tunnel on the Rock Creek development was divided among three contractors. Morrison-Knudsen Company, Inc., was alloted 4000 feet from the upper portal, and that firm and Walsh Construction Company were jointly awarded other related work. The latter is driving 7670 lineal feet from the lower end. Arundel Corporation and L. E. Dixon hold a contract for the 22,445 feet in between, which is progressing from four headings opened by two adits. The contract for driving the Cresta tunnel was let to T. E. Connolly, Inc., and the bore is being advanced from both portals and two adits—six headings.

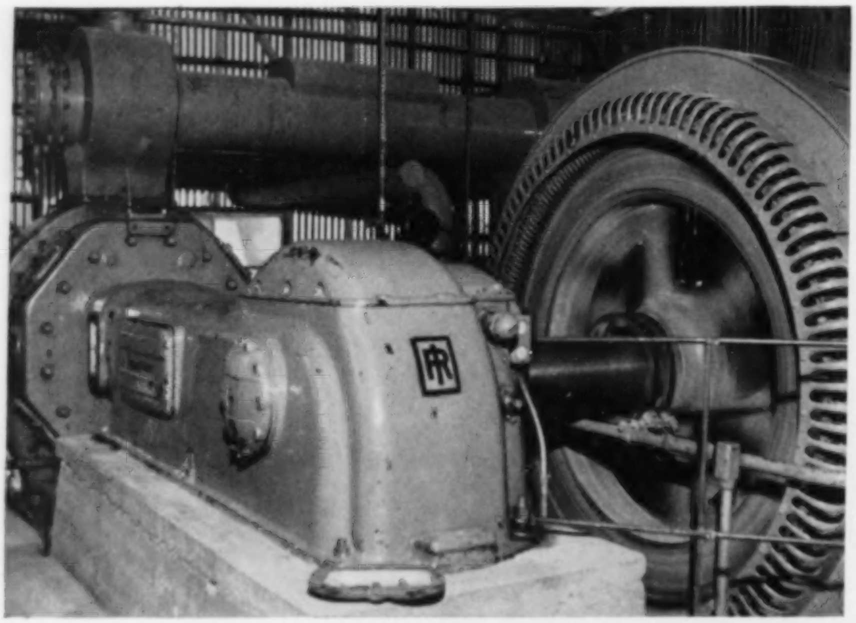
Morrison-Knudsen has completed its 4000-foot Rock Creek Tunnel section, which was drilled by the use of a gantry jumbo mounting fourteen 4-inch drifters provided with conventional steel. The upper deck of this carriage was equipped with one pneumatically and two hydraulically controlled universal booms that permitted quick set-up of drills for arch holes. One of the crews on this job drove 47 feet of 25-foot tunnel in 24 hours, a performance that has not been bettered so far at any heading on the project, though another contractor has made several weekly records. An average of 92 to 108 eleven-foot holes were drilled for each 9-foot round on a 5-round-per-day schedule. A 100-hp. Conway mucker loaded the spoil in 5-cubic-yard cars that were switched at the face by a cherry picker on a wide-gauge jumbo. F. A. Huntington was tunnel superintendent for Morrison-Knudsen and L. L. Wheeler project engineer.

By August of this year, Arundel-Dixon had driven an aggregate of 10,500 feet of tunnel from twin headings at the upper or Chambers Creek adit and 8168 feet from two faces at Jackass Creek adit. There, too, gantry-type jumbos mounting 4-inch drills are employed, and from 104 to 108 eleven-foot holes are drilled per round. Twin Conway shovels handle muck at all headings. A. L. Simpson was project manager until last June when he left for South America and J. Williams took his place.

The 7670-foot stretch being driven by Walsh Construction Company from the lower portal includes the surge chamber and is being advanced upstream by the use of a single 100-hp. mucking machine and eleven 4-inch drills mounted on a gantry jumbo and utilizing 1¼-inch rods with 1¾- and 1⅞-inch detachable bits. A round consists of 104 eight-foot holes, the cut holes being 12 feet deep. This contractor has made several weekly driving records, completing as high as 211 feet per 6-day week in one heading. Les Huntington is tunnel superintendent for Walsh Construction Company.

In July, 1947, T. E. Connolly, Inc., started operations on the separate Cresta Tunnel and on the 1470-foot diversion bore. About 770 feet of the latter is of 27-foot horseshoe section and will form part of the main tunnel; the remainder is essentially the same except for 3-foot-high side walls. This tunnel, which temporarily carried the river around Cresta Diversion Dam, was finished on May 5, 1948. The contractor first drilled a pilot bore 16x16½ feet and then slabbed it out to full size. The 20,900 feet of main tunnel is being advanced from five headings, one progressing from the lower portal and two each from adits at Grizzly and Bear creeks, respectively. That at Grizzly Creek is not a true adit but a gap formed by a narrow canyon that, as has already been mentioned, is to be spanned by a concrete conduit. Work there was begun by excavating an 8x10-foot tunnel to divert the stream so that its bed might be filled for the time being to the level of the main tunnel to carry tracks and serve as an access ramp.

Cresta Tunnel's larger diameter pro-



SOURCE OF AIR POWER

This 21-inch stroke synchronous motor-driven air compressor at the tunnel camp of Walsh Construction Company supplies air power for the tunneling operations.

duces approximately 4 cubic yards more rock per 9-foot round than does that in the Rock Creek Tunnel. Connolly now has 600 men on the payroll and is advancing four headings, three with wide-gauge gantry jumbos and one with a small carriage mounting six drills. This contractor's methods and equipment are characterized by several innovations: double-tracking of one adit and running six rails to three of the four headings. The two outer rails carry a jumbo, which spans double tracks of standard gauge and is equipped with dual cherry pickers for hoisting mucking cars. This arrangement makes another feature practicable, the working of two conventional Conway muckers side by side in one heading. This is also being done by the Arundel Corporation and L. E. Dixon on their Rock Creek Tunnel contract.

Each of the Connolly drill carriages mounts fifteen 3-inch drifters with 30-inch power-feed and using 1⅛-inch steel. These 210-pound machines have a 1-inch smaller bore than the drills generally utilized in driving a large-diameter tunnel and are set up more easily on a jumbo by its 2-man crew than the 100-pound heavier 4-inch drifter fitted with 1¼-inch steel.

From 120 to 140 eleven-foot holes are drilled in the Cresta Tunnel to pull a 9-foot round, a wedge cut with an average of six 13-foot holes being used to pull the core. Primers are of one to twelve delay. Perhaps ten to fifteen more holes per round are used than if a fairly standardized ratio of hole spacing to yardage (common to other contracts on the project) were the rule on the job. Somewhat less overbreak and closer trim is obtained by this slightly closer spacing of smaller holes, giving the unlined tunnel better contours. Figuring powder consumption and hole spacing in relation to fracturing that will insure maximum ease of mucking, the contractor believes that his method effects economies.

Bits are of the Carset type, with a series-13 stud attached to 1⅛-inch alloy-steel rods. Only one size—1½ inch—is used. This type of bit loses gauge very slowly and is reground from one to five times before being discarded. Records kept on one occasion during the course of the work showed an average performance per bit of 218 feet of hole. In holing through the diversion tunnel at Cresta intake, Connolly employed some 24-foot steels in 3-inch machines and got 8 to 10 inches per minute in hard granite. Drilling speed with the shorter steels in a normal round has averaged as high as 18 inches per minute, and one complete round has been put in in 54 minutes.

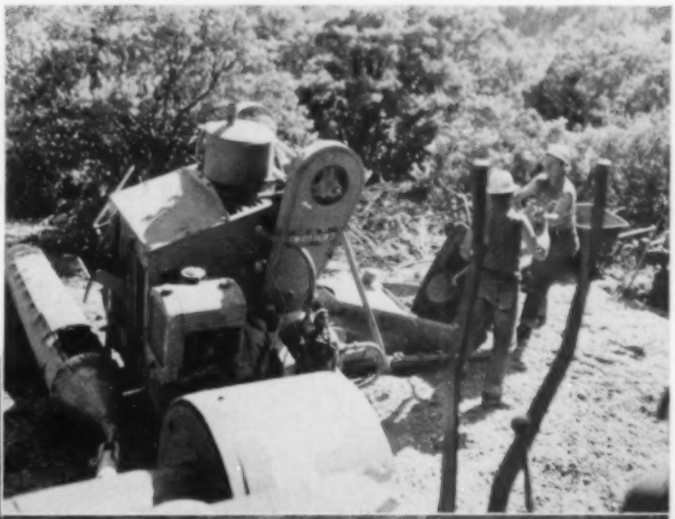
Connolly operates his drifters with air at 90 psi. and states that overhead for drill maintenance and steel replacement is much less than that normally incurred with 4-inch machines working with 100 psi. The statement has been made that fatigue failure of alloy-steel rods at points other than heated shanks and threaded ends is virtually unknown; and it is estimated that over-all steel failure is approximately one-third of that experienced with the same drifters but with carbon-steel rods.

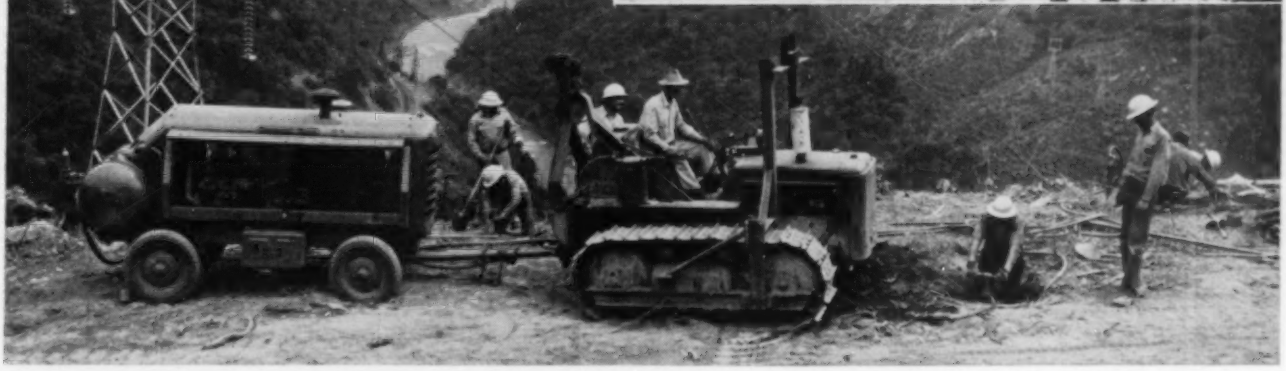
If the fifteen drills on a jumbo were provided with conventional rods, approximately 600 pieces would be required for one round, and the workers necessary to condition steel for the four headings would be correspondingly numerous. As it is, only 75 pieces are taken to the face for a round. Again, were ordinary detachable bits in use, two nippers would be needed for each drill carriage to keep up with bit changes, while one man handles Carsets easily. In a central shop, a blacksmith and helper on two shifts daily have no difficulty driving studs and maintaining shanks for the 51 drills now at work on Connolly's contract.

An unusual sinking method was resorted to in excavating for the Cresta surge chamber. Three 5-inch holes on 5-foot centers were drilled from the sur-

CRESTA POWERHOUSE

When completed and equipped with two turbine-generators and appurtenant works this structure and its feeder tunnel will have cost $26,400,000.





TRANSMISSION-TOWER CONSTRUCTION
With its own forces, Pacific Gas & Electric Company is erecting 197 steel towers for 40 miles of new transmission line to tie the two new generating stations into the existing Feather River system. One of the Mobil-Air 210-cfm. portable compressors that supply operating air to Jackhamers and pneumatic diggers for excavating tower foundations is shown below. Where a concrete mixer cannot be transported over rough or steep ground to reach a tower site, the concrete is delivered in a torpedo-shaped steel cylinder or "pig" which, with its doors closed, is pulled by a cable that passes around a sheave attached to a deadman anchored at the tower location. The view at the right shows a pig ready to receive a load of concrete from a mixer. Part of the hoist that powers the cable line is in the foreground.

face to the tunnel elevation, 120 feet down, and a fourth hole was placed at the center of the triangle formed. The holes were plugged from below, powder charges were hung at desired points with stemming between and above, and muck was shot into the tunnel and handled in the same manner as that from the headings. Enlarging of the tapered chamber is being done with Jackhamers. The material is removed to dumps where it is loaded into Euclids by power shovels and is used to widen banks along the Feather River Highway. Earl Walsh is general superintendent.

Morrison-Knudsen's contract includes the building of Rock Creek Diversion Dam and Cresta Dam. Principal excavation at both sites has been completed, and pouring of concrete is well advanced. An overhead cableway with a head tower of the contractor's own design is in service at Rock Creek Dam, and concrete produced in a Noble batching plant is being placed by 4-cubic-yard bottom-dump buckets. Two derricks—a Lidgerwood and a Clyde—handle concrete in 2-yard buckets at Cresta Dam. Both structures will be equipped with the same drum-type floating gates as those at Shasta Dam, except that those at Cresta and Rock Creek dams are to be 124 feet long—larger than those at Shasta. The same contractor is also constructing the powerhouse for the $26,400,000 Cresta development. This structure is well underway, as is the concrete building being put up by the Walsh Construction Company for the $35,400,000 Rock Creek power development.

Pacific Gas & Electric found suitable material for aggregates in a river bar near Camp Rogers, and Morrison-Knudsen is preparing it in a washing and screening plant with a capacity of 200 tons per hour. The material is stockpiled and allocated by the utility to all the contractors. Morrison-Knudsen also built many of the access roads required on the project. A. H. Johnson is area manager for the company and John L. Armitage is general superintendent.

Some 115 men on the utility's payroll are working from two camps on powerline construction, which involves the erection of 197 steel towers to carry 40 miles of new line to tie the two new plants into the existing Feather River transmission system. Jackhamers, No. 159 diggers, and other pneumatic equipment are used in excavating for their concrete foundations and are supplied with air by Mobil-Air compressors with a capacity of 210 cfm. The amount of concrete needed to anchor each tower varies from 9 to 12 cubic yards, depending upon the height of the structure. This is a considerable quantity, and its transportation to the scattered sites in the mountainous region presented a problem.

In place of the expensive high lines or tramways sometimes used for the purpose, the utility substituted a torpedo-shaped steel cylinder connected at each end to an endless cable and provided with quick-opening doors. This so-called "pig" has an over-all length of 16½ feet, weighs 1600 pounds empty, and carries 16 cubic feet of concrete. The mixer is placed at the nearest point on the access road, a sheave is anchored by a deadman at the tower site, and the cylinder is shuttled back and forth between the two by a hoist either mounted on a skid or taking power from a tractor The long cylinder bounces merrily along dodging boulders on precipitous slopes.

The project was designed by the Pacific Gas & Electric Company's own engineering department. J. A. Koontz and his principal assistant, E. F. Maryatt, have charge of the electrical-mechanical features and W. Dreyer and his principal assistant, T. J. Corwin, of the structural and hydraulic features, all under the direction of I. C. Steele, vice-president and chief engineer.

Execution of the project is under the direction of O. W. Peterson, engineer of general construction, with supervision of the work under H. W. Haberkorn. A. J. Swank is in charge of the electrical-mechanical installations; J. E. Cooney is project superintendent; G. B. Thacher is project engineer; and J. W. Woodward is resident engineer.

The N & W's New Elkhorn Tunnel

By Reducing Grade and Curvature, New Large Bore Will Speed Up Service on Leading Coal Carrier

Walter P. Gillingham

OLD ELKHORN TUNNEL

An electric locomotive is seen emerging from the Coaldale portal of the 60-year-old, single-track bore that will be replaced by the larger one described in this article.

TUNNEL PORTAL AND CAMP

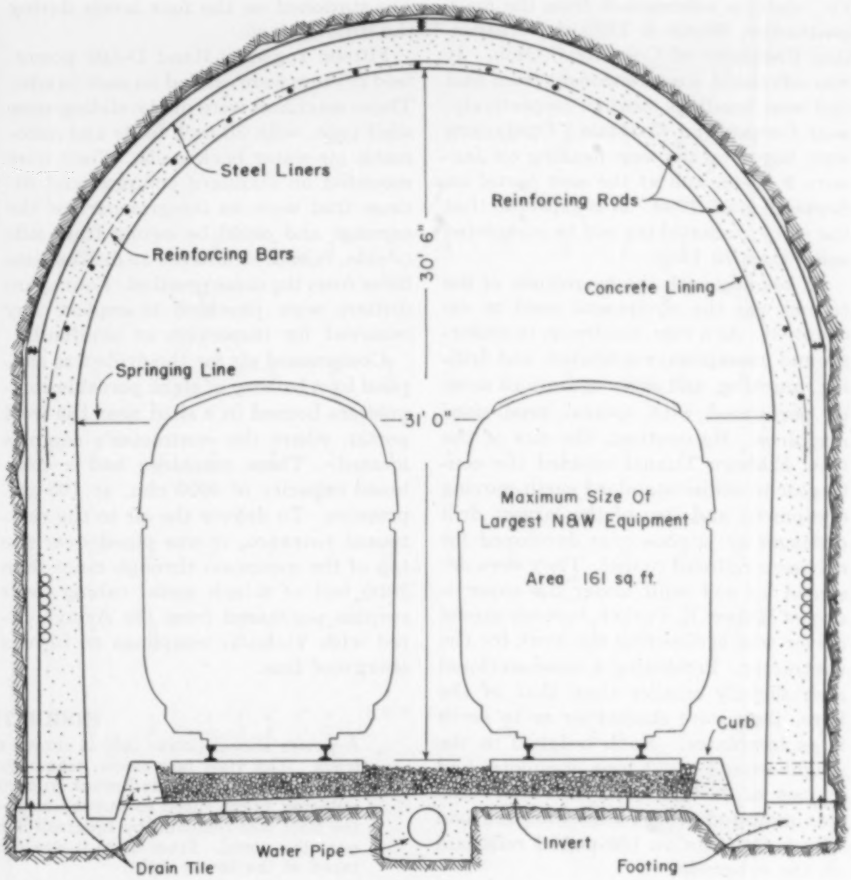
Views in two directions from the same spot are shown above. At the top-center, a muck-laden truck is shown emerging from the west portal. Ventilating lines may be seen extending into the bore from two small buildings that house blowers. In the foreground is a concrete batching plant for use in lining the tunnel. The contractor's camp is pictured just above. The long building contains the air compressors, and beyond it are offices, shops, dormitories, etc. A sawmill is at the right.

ONE of the world's largest railroad tunnels has been driven through Flat Top Mountain near Bluefield, W. Va. A horseshoe-shaped bore 36 feet wide and 35 feet high, it has a finished length of 7052 feet. It is part of a $12,000,000 project being carried out by the Norfolk and Western Railway to relocate and modernize the section of its double-track main-line Pocahontas Division that lies approximately 12 miles west of Bluefield and connects the towns of Lick Branch and Cooper.

The old Elkhorn Tunnel, which the one under construction will replace, was excavated for the N & W in 1887-88 when the then fast-expanding young railroad was striving to reach the newly discovered coal fields of Virginia and West Virginia. Although small by today's standards—but 3015 feet long and with a single track—it was a major factor in the development of the system. Its completion enabled the N & W to pass through the Appalachians and tap the nation's largest deposits of bituminous coal. Symbolic of the product that was to form and still constitutes the major share of the freight carried is the fact that the tunnel was driven in its entirety through a seam of coal 10 feet thick.

In addition to the tunnel, the project involves the relocating and building of more than 5 miles of double-track line, the erection of two steel bridges and the reconstruction of a third, and the reduction of existing grades and curves. The present road ascends eastward from Lick Branch on grades as steep as 2 percent and westward from Cooper on a 1.1 percent grade. Between these sections is a 1.4 percent gradient on which the line narrows to single track to pass through the old Elkhorn Tunnel. This bottleneck, the steep grades, and the presence of curves as sharp as 14 degrees, combine to limit the amount of traffic the line can handle.

The new stretch will rise from Lick Branch eastward on a maximum 1.4 percent compensated grade. From Cooper westward it will be on a 0.5 percent up-


Steel Liners
Reinforcing Bars
Reinforcing Rods
30' 6"
Concrete Lining
Springing Line
31' 0"
Maximum Size Of Largest N&W Equipment
Area 161 sq. ft.
Curb
Water Pipe
Invert
Drain Tile
Footing

TUNNEL SECTION

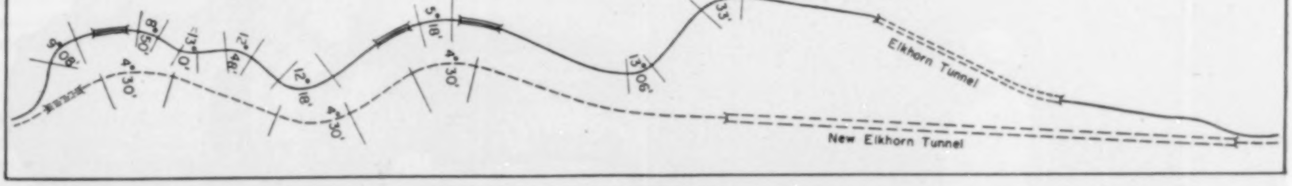
A cross section through the bore as it will be when completed. It was designed for this large size (835 square feet area) to assure ample clearance for the largest N & W rolling stock and also to facilitate thorough ventilation.

grade and then continue through the double-track tunnel on a minus 1 percent downgrade. The elevation of the two new bridges will be considerably lower than that of existing spans, the viaduct being rebuilt at Cooper will be slightly lower than the original structure, and the tunnel is more than 100 feet below the level of the old one.

The undertaking will accomplish the following: 1– Flatten grades to a maximum of 1.4 percent, compensated; 2– reduce curves to a maximum of 4½ degrees; 3– lower the summit of the haul by 63 feet; 4– shorten the run by 1900 feet; 5– eliminate the traffic bottleneck caused by the single-track tunnel. These improvements will make it possible to haul more tonnage per locomotive, as well as to route more trains per day over the division. In addition, the road will be equipped with modern automatic switches and signals. Centrally located, they will permit complete control over trains traveling in either direction on either track.

Of the entire program, the New Elkhorn Tunnel is by far the biggest job both as to cost and time and effort required to carry it to conclusion. It is more than twice as long as the old structure and more than 3½ times as great in cross section—in short, it is the longest and largest bore in the N & W system. Of the 1,000,000 cubic yards of material excavated in the course of the project, the tunnel accounted for 315,000 yards. In excess of 5000 tons of steel liners were used to brace its roof and sides, while lining operations will call for some 90,000 cubic yards of concrete and 555 tons of reinforcing steel.

The tunnel was driven by Haley, Chisholm & Morris, Inc., of Charlottesville,


MAYBEURY
COALDALE
9° 08'
8° 50'
13° 0'
12° 48'
12° 18'
5° 18'
13° 06'
7° 33'
4° 30'
4° 30'
4° 30'
Elkhorn Tunnel
New Elkhorn Tunnel

COMPARISON OF ROUTES

Sketch of new and old tunnel routes and their western approaches, showing some of the major reductions in curvature that will be effected by the relocation. The lower elevation of the new bore will also reduce the climb of the new approaches and eliminate the use of three high viaducts near Maybeury (shown as triple lines).

Va., under a subcontract from the main contractor, Sturm & Dillard Construction Company of Columbus, Ohio. It was advanced simultaneously from east and west headings located, respectively, near Cooper and Coaldale. Operations were begun on the west heading on January 9, 1948, and at the east portal on September 24, 1948. It is expected that the whole undertaking will be completed some time in 1950.

In keeping with the magnitude of the tunnel was the equipment used to excavate it. As a rule, headroom in underground passageways is limited, and drilling, mucking, and other operations must be performed with special, small-sized machines. By contrast, the size of the New Elkhorn Tunnel enabled the contractor to utilize standard earth-moving equipment and two of the largest drill carriages or jumbos ever developed for driving a railroad tunnel. They were designed by and built under the supervision of Robert E. Parker, veteran tunnel driver who is directing the work for the contractor. Presenting a cross-sectional area slightly smaller than that of the bore, they were shaped so as to serve it as templates. Each weighed in the neighborhood of 32 tons complete, had frames of 10-inch steel H-beams, and was mounted on six cast-steel railroad wheels that ran on 100-pound rails laid on the subgrade.

There were four platforms of 4-inch oak planking on each jumbo. The central sections of the two lower decks were hinged and held in a horizontal position during the drilling cycle by cables attached to the third-level platform. While mucking was in progress they were dropped to provide an opening through which trucks and other equipment could pass to the working face. The fourth or upper platform, which was necessarily narrower than the others because it conformed to the contours of the bore, was permanently mounted on supports resting on the deck beneath. A crew of 35 men—drillers, helpers, and foremen—was stationed on the four levels during the drilling cycle.

Fifteen Ingersoll-Rand D-505 power-feed drifters were carried on each jumbo. These machines were of the sliding-cone shell type, with 30-inch feeds and automatic air-water backheads. They were mounted on standard columns and fittings that were an integral part of the carriage and could be swung from side to side, raised, or lowered to drill several holes from the same position. Four spare drifters were provided to replace any removed for inspection or overhaul.

Compressed air for the drills was supplied by a battery of eight portable compressors housed in a shed near the west portal, where the contractor's camp is located. These machines had a combined capacity of 4000 cfm. at 105 psi. pressure. To deliver the air to the east-tunnel entrance, it was piped over the top of the mountain through more than 7800 feet of 6-inch metal tubing—war surplus purchased from the Army—fitted with Victaulic couplings to form a leakproof line.

The daily rate of advance from the west portal from the beginning of operations was one round drilled, blasted, and mucked in two 10-hour shifts, including the setting of steel liners to support the sides and roof. When the crew went on at 7:30 p.m., the jumbo was moved up to the face and a total of 210 holes was drilled in a modified V-cut per round. Type 2, side-hole Jackbits, ranging in size from 2½ to 1¾ inches, were used with 1¼-inch hollow rods in lengths permitting 30-inch steel changes. Holes were drilled to a depth of 15 feet, which normally resulted in an advance of 14 feet. The entire drilling cycle took about 7½ hours.

Next, the holes were loaded from the jumbo platforms with about 1800 pounds of 40 percent gelatin dynamite. Ten sizes of delayed-action blasting caps, arranged to fire at intervals of one second, were inserted with the charges. They were wired together in parallel and detonated with 440-volt alternating current after the drill carriage had been run back a safe distance from the working

INSIDE THE TUNNEL

A power shovel (lower left) is shown swinging a load of muck over to a waiting truck. The view just below, taken from the top of the drill carriage in the east heading, shows a loaded muck truck on its way out. Near the portal is a diesel-powered crane, used to put the steel arch liners in place. The water covering the floor was removed by Ingersoll-Rand sump pumps that delivered it to a sump near the portal. From there it was pumped outside by the two Motorpumps pictured at the lower right.

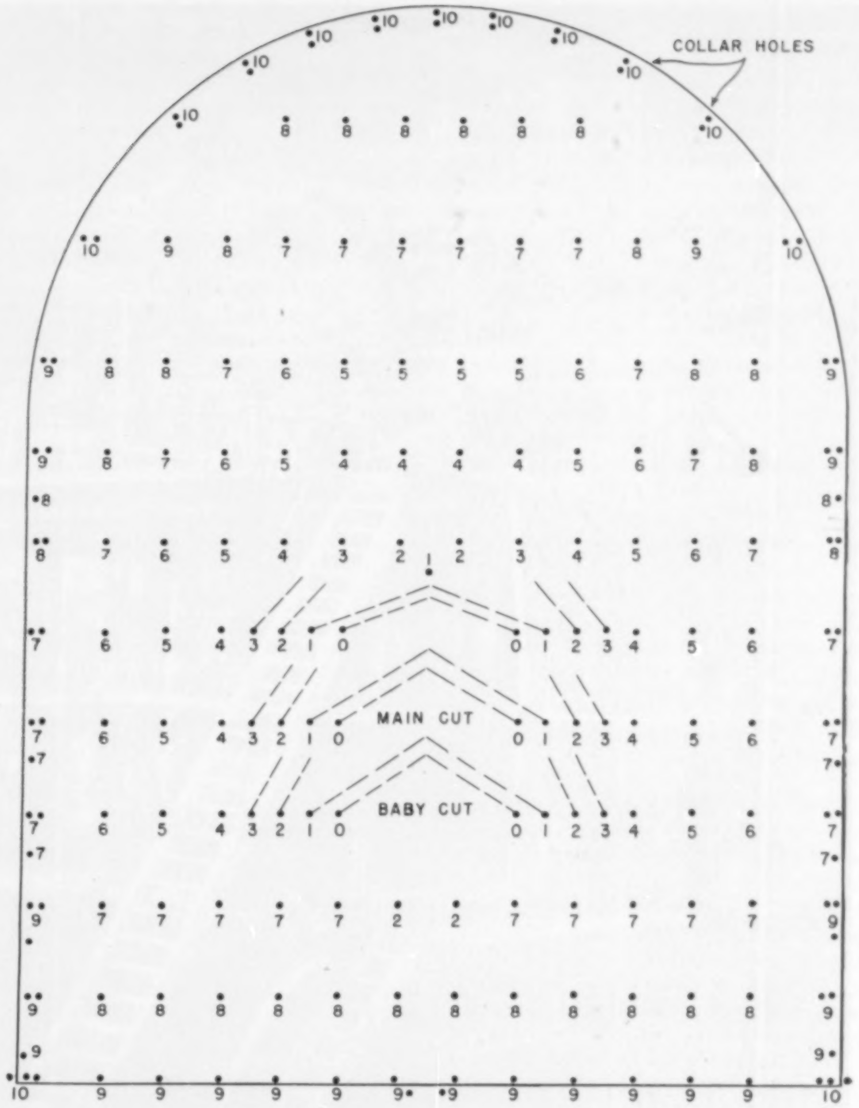
face. Each shot produced some 700 cubic yards of material.

All mucking at the west heading was done during the day shift. The inner platforms of the jumbo were swung aside to allow a Lorain diesel-powered shovel with a 2¼-cubic-yard dipper to move up to the face. At the same time, 15-ton rear-dump Euclid trucks, also operated by diesel engines, began to rumble into the tunnel. One after another they turned around at the heading, backed up to the shovel for loading, and returned, the bore being so wide that two trucks could easily pass each other. Upon emerging, they dumped their loads in fill areas near the portal where work on the approach grades for the new tracks is nearing completion. Mucking took from five to six hours, and at intervals during the cycle the spoil was sprayed with water to keep down dust. Assisting in the operations was a diesel-powered tractor that maintained haulageways and shifted the drill carriage and other equipment.

The tunnel has been driven through hard sandstone, and some shale and slate were encountered. Several seams of coal were cut, the largest being the Pocahontas No. 2. Before actual work was started, the N & W made a geological survey of the mountain to determine the character of the rock and also to locate possible beds of coal. Diamond-drill holes were put down at 1000-foot intervals along the tunnel line and extended approximately 20 feet below grade. The deepest was 440 feet and the shallowest 170 feet. The cores were examined and logged, the data thus obtained enabling the drilling crews to advance with full knowledge of the formations they would encounter as they progressed.

Because the nature of the rock was such as to require support, steel liners were used to brace the roof and sides. They were set within a few feet of the face as soon as a round had been mucked out. This practice reduced excessive breakage from the walls and roof during the next blast and assured the workers maximum protection against falling rock. The liners are wide-flange, 8-inch, 35-pound H-beams and came in four sections—two posts and two quarter-circle arcs. The former were raised by hand and rest on 6x12-inch timber sills while the arches, which were bolted to the posts and to each other, were put in position by means of a diesel-powered crane.

To insure uniform spacing, ¾-inch tie rods and 4x4-inch hardwood blocks were placed horizontally between adjacent sets of liners and, where needed, wood blocking was wedged between the liners and the rock. Some of the timber required for these purposes was cut from local trees in the contractor's own sawmill. When work was first started at the west portal, the liners were spaced 18 inches apart, but it was subsequently found safe to increase the distance to 30 inches. They will remain in place when the tunnel is concreted to form an integral part of the lining.



BLASTING DIAGRAM

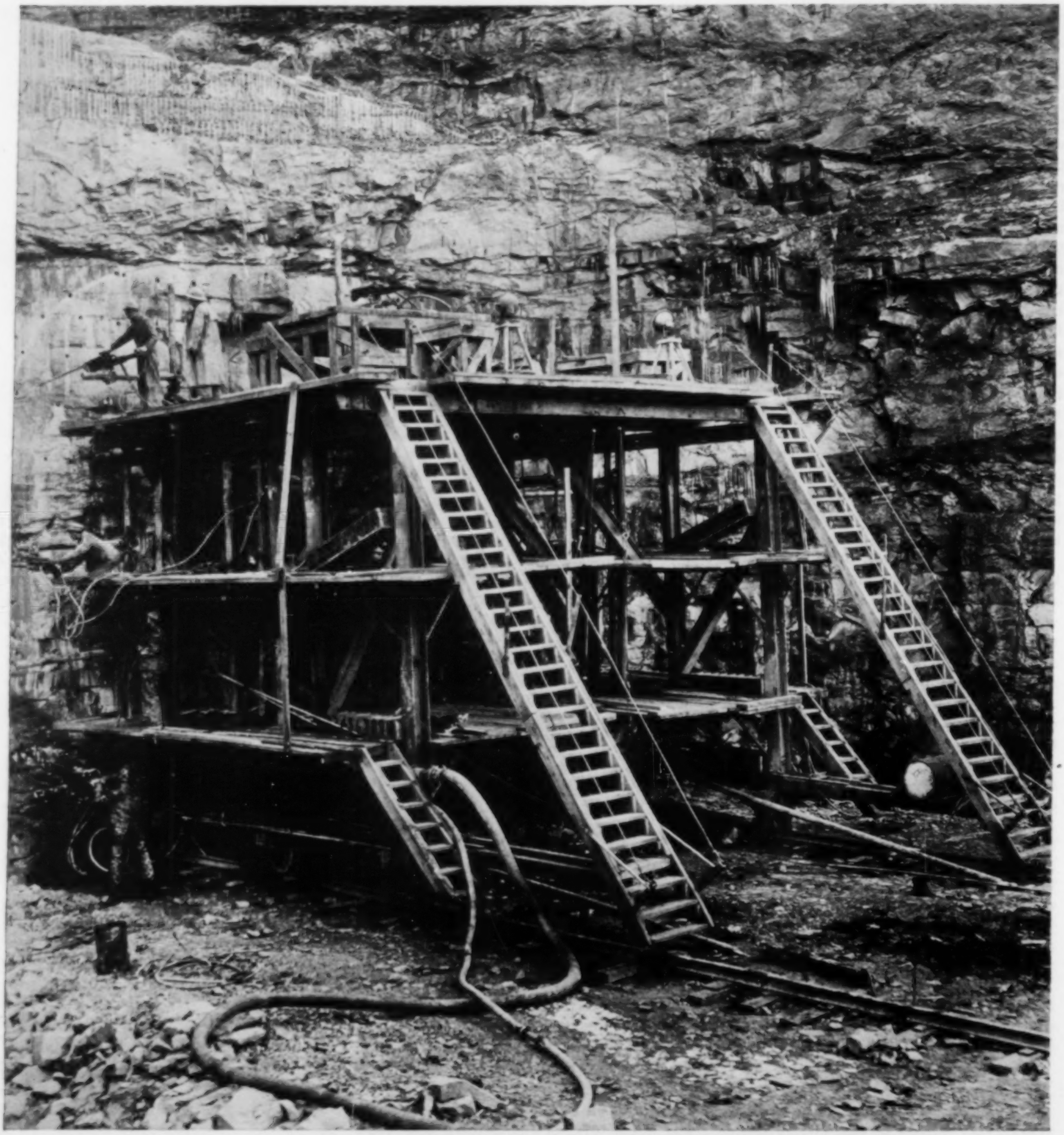
A typical drill round consisted of 210 holes, positioned as shown here. The collar holes were 3 feet deep and the others 15 feet in the west heading and 18 feet in the east heading. The order of firing with delay detonators is indicated by the numbers.

The east heading is far removed from the main base of operations, and that accounts for the fact that progress there was only about half as fast as that at the west end, even though the work was carried on in a similar manner and with like equipment. The crew worked one 10-hour shift a day, and it took two days to advance one round. Drilling was done in the daytime, so as not to coincide with drilling at the west face, and the following day was devoted to mucking and setting up steel liners. A round was normally carried to a depth of 18 feet and resulted in an advance of 17 feet. Starter bits were of 2⅝-inch gauge, and holes were finished with 1¾-inch bits.

As the tunnel grade is upward from west to east, the heading at the former end had natural drainage, while water from drills, seepage, condensation, etc., that collected in the eastern section had to be continually removed from the working face. Ingersoll-Rand Type 25 air-operated sump pumps transferred it to a point near the portal, where it was picked up by two Motorpumps that discharged it over a nearby bank.

To maintain adequate ventilation and to exhaust fumes from the diesel-powered equipment, three mechanical blowers—two located outside of the west entrance and one at the east portal—were run continuously while work was going on. They were Ingersoll-Rand Type FS-573 units, each having a capacity of 21,000 cfm. at 3550 rpm. and driven by a 200-hp. electric motor. Naylor 30-inch-diameter spiral-welded pipe delivered the air close to each heading.

The contractor's main camp, at the



KING-SIZE DRILL CARRIAGE

The drill carriage is a time-saving device in driving large-section tunnels because it permits massing multiple drills for the attack on the rock face. Two of these structures, familiarly termed jumbos, were designed especially for this job. Each weighed 32 tons and consisted of timber platforms on a steel framework, the whole assembly mounted on six railroad wheels running on widely spaced tracks made up of 100-pound rails. At the front, 15 Ingersoll-Rand 505 drifter drills were mounted on columns and bars so that they could be moved horizontally or vertically for drilling several holes. The central portions of the two lower platforms were hinged so that they could be let down to form an opening through which trucks and other equipment could pass during the mucking cycle. A drilling crew normally comprised 35 men. The picture shows the carriage at the west portal drilling the first round in the squared-up rock face when work was started there in January of last year. At this heading, the drilling of an average round entailed putting in a total of around 3150 feet of hole, or 210 feet per drill.

western end of the tunnel, includes offices, service shops (carpenter, blacksmith, drill repair, etc.) and the sawmill. There are also dormitories with individual rooms for single men on the job, a dining room that serves meals around the clock, and other aids to comfortable living that rate Bob Parker's camp high in the estimation of his men. A heated change house has facilities for drying clothes between working periods, and hot water for showers and washrooms is available at all hours. It is supplied by a portable, oil-fired Frick boiler that also provides steam for heating the various

ROBERT E. PARKER

Veteran tunnel driver in charge of the construction, pictured holding a fossil taken from a coal bed penetrated during the work. Important jobs previously carried out by Mr. Parker were tunnels on the Pigeon River Project of Carolina Power & Light Company in North Carolina; construction of Wanaque Dam and Great Notch Tunnel for the Newark, N. J., water-supply system; the 18.6-mile Edisto River-Goose Creek bore for delivery of water to Charleston, S. C.; tunnels for the New York City water system; and vehicular tunnels on the Pennsylvania Turnpike.

buildings during cold weather periods.

Power for lights, motors, and other electrical requirements reaches the main camp at 66,000 volts over a special line that will become a permanent part of the project. There it is stepped down by transformers to 2300, 440, and 110 volts. Power for the east end was transmitted over the mountaintop at 2300 volts and reduced to the lower voltages.

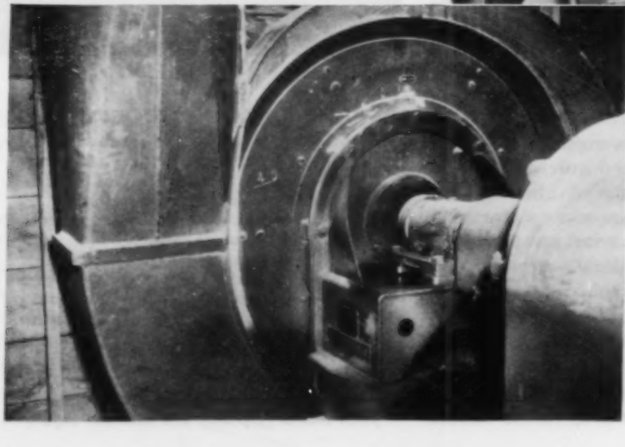
When the job was visited on June 15, approximately a week before the tunnel crews holed through, concreting from the west portal was already underway. Workmen were busy pouring footings approximately 4½ feet wide and 2 feet thick and placing a 6-foot-wide strip of the invert and a 2½-foot-high wall section along each side. The strips of invert will have a minimum thickness of 6 inches and will serve to support the two movable, 45-foot-long steel forms that will be used to line the walls and arch. One will start at the east portal and the other midway, both traveling westward on rails.

From the main concrete batching plant near the west entrance a fleet of diesel-propelled Autocars will transport the material into the tunnel and transfer it to electrically operated Pumpcrete machines with double discharge lines that will permit placing concrete at two points in the forms. Each truck carries a 4½-cubic-yard mixer driven through a power take-off from the engine and is equipped with an unloading pump operated through a second power take-off. Measured from the face of the liners, the concrete will gradually increase in thickness from 18 inches throughout the arch to 24 inches at subgrade. The arch lining will be reinforced longitudinally with ½-inch round tie rods set 3 feet apart and transversely with 1-inch square bars on 18-inch centers curving from a point near the outer surface of the concrete at the springing line to a point close to the inner face at the crown.

The entire floor of the tunnel will be of concrete and on it will be spread crushed-stone ballast 18 inches deep and 23 feet wide between curbs to form the roadbed. The space between the curbs and side walls will become drainage gutters 2½-feet deep. A cast-iron pipe, 14 inches in diameter, will be encased in the concrete under the center of the invert to carry water through the tunnel; and 85,000 feet of conduit, embedded in the side-wall lining, will carry signal, telephone, telegraph, and high-tension lines. Moisture collecting on walls will be disposed of by 26,000 feet of drain tile.

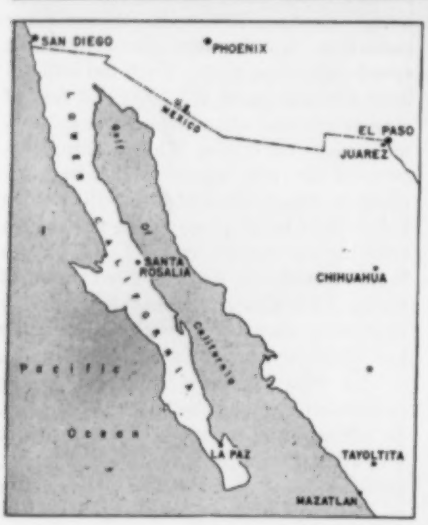
Unlike many railroad tunnels, the New Elkhorn will not fill up with choking clouds of smoke and cinders when coal-burning locomotives pass through. This nuisance will virtually be eliminated by installing two large-capacity Sturtevant fans in a special housing at the west portal. They will be driven by Westinghouse 400-hp., 2300-volt, wound-rotor induction motors through 4.73 to 1 speed-reduction units. Each fan will deliver a minimum of 477,500 cubic feet of air per minute when turning at its normal speed of 370 rpm. The resulting current of air will travel eastward—upgrade. Eastbound trains will reduce their speed to 10-12 miles per hour upon entering the tunnel, and the smoke from their locomotives will be blown ahead of them. Westbound trains will merely close their throttles to cut off the smoke and drift downgrade through the tunnel.

The New Elkhorn Tunnel is being constructed under the supervision of A. B. Stone, chief engineer of the Norfolk and Western Railway, and W. L. Young, assistant chief engineer. B. E. Crumpler is assistant engineer on the job and C. W. Fiery and Roscoe Porter are resident engineers on the west and east sections, respectively. John R. Morris is president of Haley, Chisholm & Morris, Inc., and Robert E. Parker is manager of tunnel construction. Ben Pretty is assistant superintendent, D. M. Carlisle is in charge of operations at the east end, and Walter Pack is in charge of the night shift at the west end.



SOURCES OF AIR

Compressed air at 105 psi. pressure for operating rock drills, sump pumps, etc., was furnished by eight portable compressors, seven of which are shown above. They are Ingersoll-Rand 500-cfm. units, driven by Waukesha diesel engines. The other view shows one of the I-R blowers that supplied low-pressure air for ventilating the bore.



LOCATION MAP

Tayoltita, shown in the lower right-hand corner, is tucked away in the rugged Sierra Madre Mountains, roughly 800 miles south of the U.S. border.

A Trip to Tayoltita

Roger V. Pierce

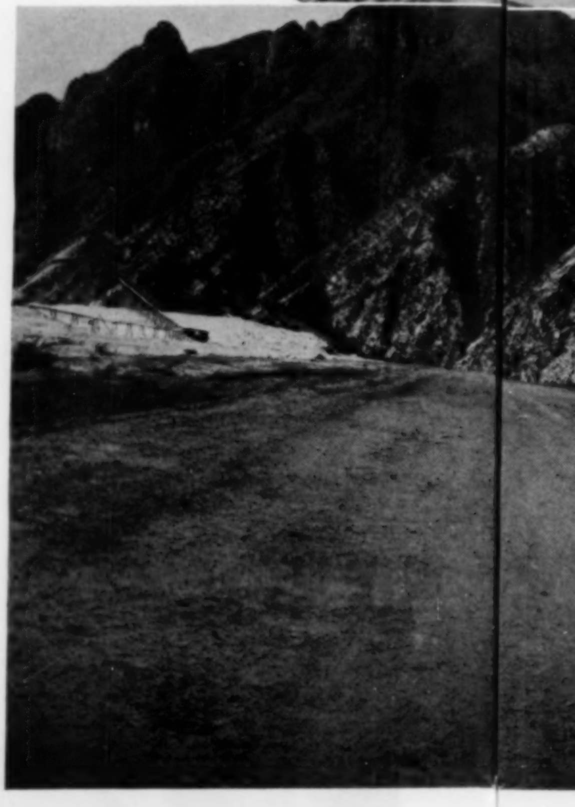
TAYOLTITA, historic Mexican silver-mining camp, is some 90 air miles inland from the Gulf of Lower California and almost due east of the southern tip of the Peninsula of Lower California. The easiest and quickest way to reach it is to fly from Los Angeles down the finger of land, then across the gulf to Mazatlan and on over the mountains. Santa Rosalia, seat of old copper mines and, more recently, of manganese operations, is half way down the 900-mile-long peninsula, and the air trip from there to Mazatlan is interesting. For the most part, you fly low enough along the coast line to see its contours through the cloudless atmosphere and the desert country that borders it.

Mazatlan, the stopover point, where weather and water are warm the year round, is a resort city. It is known for its alligator-leather goods, is a transportation center, and the hub of long-established mining activities. The natives will tell you proudly that it is more than 300 years old. But it is the remainder of the journey that is really impressive. No matter how seasoned an air traveler you are, you will never forget the flight from Mazatlan to Tayoltita in the high and rugged Sierra Madre Mountains. You will pass over some of the roughest terrain in North America and land on an airfield the like of which you have never seen before and hope you won't see again.

One thing is sure; if you fly to Tayoltita you will get up in the morning. There are always treacherous air currents in the narrow canyon of the Piaxla River that must be followed for a part of the way and especially where the airport sits like a postage stamp in the stream bed, hemmed in by mountains from 6000 to 8000 feet high. As the atmosphere is calmest early in the day, that is when the run is made.

We were at the Mazatlan airfield at 5:30 and took off just as daylight was breaking. The trip takes only 35 or 40 minutes, but the final stage is a thrilling experience. After passing over the range, the plane eases down into the river canyon and follows its weaving course. Upon approaching the airport, it makes a wide turn to miss a bench-like mountain, drops into the narrow section of the canyon where the clearance on either side seems to be no greater than the law allows, and then comes down on the field that was made by leveling off a mill-tailings dump. It is on a slope, thus helping to stop the 12-passenger Boeing within the allotted space. It was laid out that way to compensate for lack of length. In fact, it was the first inclined field for heavy aircraft ever built, one at Bulolo, New Guinea, being the second.

Upon landing, passengers, mail, and express were discharged quickly and the outgoing load was placed aboard in a few minutes. The idea was to start the return hop before the wind got to acting up too much. The plane taxied to the upper end of the airport and shortly roared down the incline for the take-off. It is always a close shave getting the ship into the air before the end of the runway is reached, and then to gain altitude, turn the craft into the canyon, and avoid

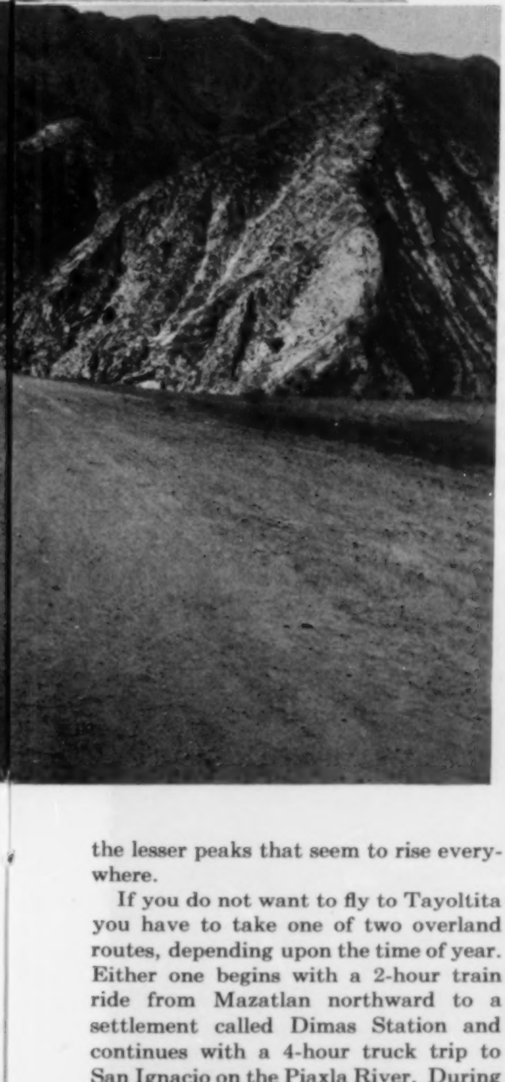


TRANSPORTATION CONTRASTS

If you go to Tayoltita, you either travel very fast or very slow, for you have your choice of riding an airplane or a mule. Automobile roads are non-existent. As a plane pilot taxies down the runway at Tayoltita for the take-off, he is confronted by the view just above. He must put his craft into the air quickly and then swerve sharply to the left to avoid the mountains. Natives awaiting the arrival of the plane from Mazatlan are shown at the top-right. The lad at the left is sitting on a stack of silver bars, which are flown out unboxed. Burro pack trains (top-left) are familiar sights.

LUNCH FOR A MINER

The miners live in villages close to their work and a hot lunch is brought to them each day. In the bucket the boy is carrying are four trays, one above the other, with a bottom compartment for live coals or charcoal to keep the contents warm.



the lesser peaks that seem to rise everywhere.

If you do not want to fly to Tayoltita you have to take one of two overland routes, depending upon the time of year. Either one begins with a 2-hour train ride from Mazatlan northward to a settlement called Dimas Station and continues with a 4-hour truck trip to San Ignacio on the Piaxla River. During the arid season from mid-June to mid-September, when the stream is at low level, bulldozers cut a crude roadway in the dry stretches, paralleling and crisscrossing the river bed as conditions necessitate.

It is about 75 miles from San Ignacio to Tayoltita by this tortuous route, and it will take you eighteen hours to cover it by muleback. On the way, you may cross the stream close to 160 times. When the rains come, the waters swell to a turbulent stage, and a high mule trail is used. There is one stretch of 8 miles where the narrow pathway passes through eighteen tunnels, some of them from 150 to 700 feet long, and there are innumerable places where it runs perilously close to the edge of sheer precipices and gives you the impression of being suspended in midair.

And yet, despite these transportation drawbacks and obstacles a modern mining camp has been established at Tayoltita over a period of years. Power plants, aerial tramways, a complete mill, compressors, and all essential equipment have been moved into the remote area. In 1936, tractor-train freighting was adopted because it was found that the river bed could be partially cleared during the low-water season to serve as a road for haulage of this kind. The trains carried about 60 tons each trip, and three were made every month. In 1941 multiple-drive trucks were put in service. These bring all the heavy supplies into Tayoltita during the dry period.

Tayoltita (pronounced Tyol Teé Ta) is an old Indian name, the translation of which seems to be unknown. Mining has been in progress there for nearly 200 years, and it can be safely stated that every advance in that field of endeavor from the crudest hand methods to the highly mechanized practices of today has been known in the history of the camp. About 1825, H. G. Ward visited a large number of the mining areas in Mexico for certain British investors. He traveled with his wife, who sketched items of interest in the settlements and camps to illustrate his report. His comments on the methods and equipment of that day are extremely enlightening, especially to those in charge of present operations who, from time to time, break into old workings and can see the results of those early chapters in the story on mining.

He wrote: "The state (Durango) is rich in mineral deposits, none of which, excepting Guarisamey and San Dimas have been at all extensively worked. (These mines were in the same general area as the present ones at Tayoltita.) There is hardly a single mine exceeding 100 varas (275 feet) in depth; for, in general, the use of even the simplest machinery was unknown in the north; and a malacate (hoist), primitive as the invention is, would have excited almost as much astonishment as a steam engine itself. The mines were worked as long as the water could be raised without inconvenience by two or three tenateros (carriers, with leathern buckets); and abandoned when the discharge of this duty became too laborious. Most of the principal districts may consequently be regarded as virgin ground; and there are few in which the old shafts might not be again brought into activity with a comparatively small outlay.

"A large portion of the territory of Durango is situated upon the tableland,

and the capital, though surrounded on most maps by mountains, lies in the midst of a vast plain which to the northeast extends with few interruptions as far as Chihuahua.

"Before the discovery of ore at Guarisamey, Victoria was a mere village (pueblo ranchero) which, as late as 1783, contained only 8000 inhabitants. The great streets, the plaza mayor, the theatre, and all the principal public edifices were built by Zambrano, who is supposed to have taken from his mines at San Dimas and Guarisamey upwards of thirty millions of dollars.

"The bonanza of Bolonos, upon its first discovery, was celebrated, but the mine was abandoned in consequence of the failure of an adit commenced with great magnificence but so badly conducted that, after wandering in various directions in search of the lode at a very considerable expense, it came out again on the side, at a very little distance from the point where it had entered the mountain."

Of the amount of silver drawn from the Sierra Madre by Zambrano during the 25 years that he continued his labors, nothing certain is known, but according to notes made by a Mr. Glennie, which include the foregoing quotation, he personally saw eleven million dollars registered in the books of the customhouse of Durango as the sum paid by Zambrano as the king's fifth. Guarisamey, now a ghost town, was a city of 10,000 to 15,000. A few dobe walls remain, and the old church still stands.

The camp was about 5 miles up the river from Tayoltita and it was there, during the last 150 or 200 years, that many pages of mining history were written. There the ore was once carried out of tunnels by burros, laden with

LAND SET ON EDGE

A view into the valley from a point near the mine. Scattered around the hillsides are various native settlements occupied chiefly by miners, while far below are the town of Tayoltita and the river.

TRAMWAY AND MILL

An aerial tramway nearly two miles long transports 20 tons of ore per hour from the lofty mine to the mill in the valley below. The mill (right) treats 300 tons of ore daily by the cyanide process and is one of the most modern in Mexico.

SUPERVISORS' HOMES

The mine operating personnel occupies the settlement pictured at the right. Some of the varied types of tropical fruit trees that thrive there are illustrated below.

sacks slung across their backs. As methods improved through the years it was possible to take more and more marginal ore. The present company applies modern geological methods which enable it to figure the structure and fault pattern so that scientific mining can be practiced. This, along with underground mechanization, up-to-date haulage to the mill, and efficient milling, permits it to work areas that would not have yielded a profit by the means previously employed.

The ore bodies are very irregular. In fact, a plan section through a stope would in many cases look much like a man's hand with outstretched fingers. The latter would represent the lenses of ore extending into waste rock. These have to be mined in a fashion that lends itself to varying widths and to irregularity along the strike of the vein. Close supervision and daily stope-assay control are maintained so that the grade of the ore can be kept within economically allowable limits. In old mined-out stopes can be seen numerous waste pillars of every imaginable shape.

Today, mining is being conducted by the San Luis Mining Company, which came into the district and started prospecting about 1892. In 1908 the first air compressor was brought in. Until that time, all drilling had been done by hand in a series of small high-grade operations. With the advent of closer mapping and geological study, and the introduction of machinery, it was possible to concentrate on the larger low-grade bodies that had remained untouched. In going through the old workings, it is evident that the Spaniards did an excellent job of following a vein so long as they could see it, but they were lost when any geological disturbance was encountered.

The veins occur in andesite in very irregular, erratic lenses, and to further complicate the problem of recovery they are badly cut by faults. They dip steeply from 60 degrees to nearly vertical and vary in thickness, but for the most part are from 6 to 10 feet wide. The ore mined is argentite or silver sulphide, with some gold values.

In general, the ore is obtained by the shrinkage-stoping system, but there are some sections with underhand stopes. With fingers of ore often splitting off from the main body, mining methods have to be flexible. All drilling is done with either power-feed drifters or rotating stopers. Detachable Jackbits of the Sibley type are standard.

At present, a 10x10-foot transportation tunnel is being driven to tap areas below the existing workings. Drilling is done with five 3½-inch power-feed drifters mounted on a portable jumbo, and a burn-cut round of 26 holes, 7 to 9 feet deep, is put in in about three hours. All broken rock is handled by an air-motor-operated mucking machine which loads the material into 3-ton Granby side-dump cars. On a three-shift basis, the heading has been advanced as much as 400 feet in one month. The haulage system includes 15-ton trolley locomotives. After the bore has been advanced a distance of nearly 3 miles, a raise will be driven to tap the present workings. Timber, mostly hardwood, is used where necessary and is brought in on muleback, the trip requiring two days.

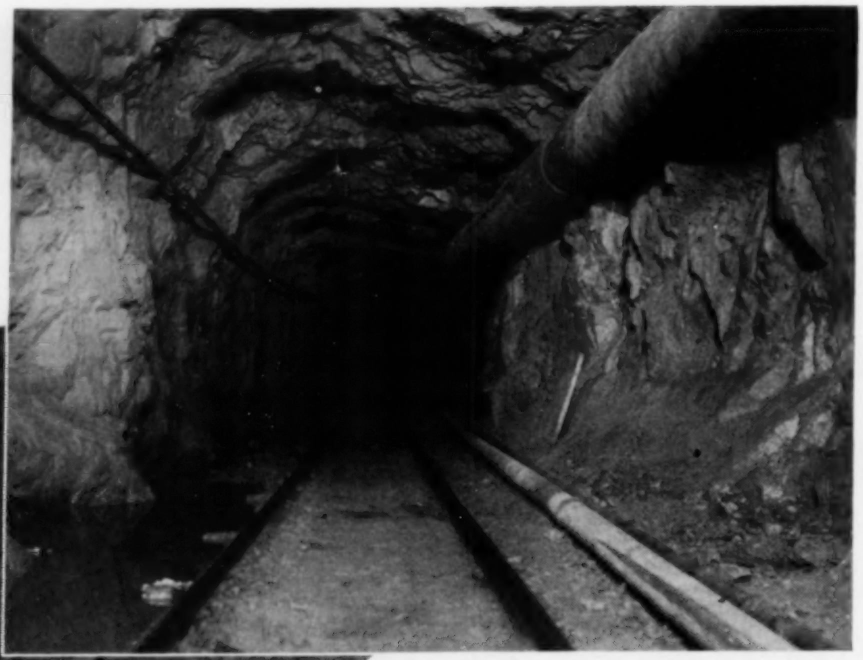
The mine produces around 300 tons of ore daily. It is dropped into a crusher and the product is transported from the mine portal at Elevation 3600 to the upper terminal of an aerial tramway at an altitude of 3500 feet. The system, which is 9750 feet long and equipped with buckets holding 1/3 ton each, delivers 20 tons an hour to the mill at river level, approximately 2000 feet below. The first cable for the tramway was pulled up the mountainside by hand.

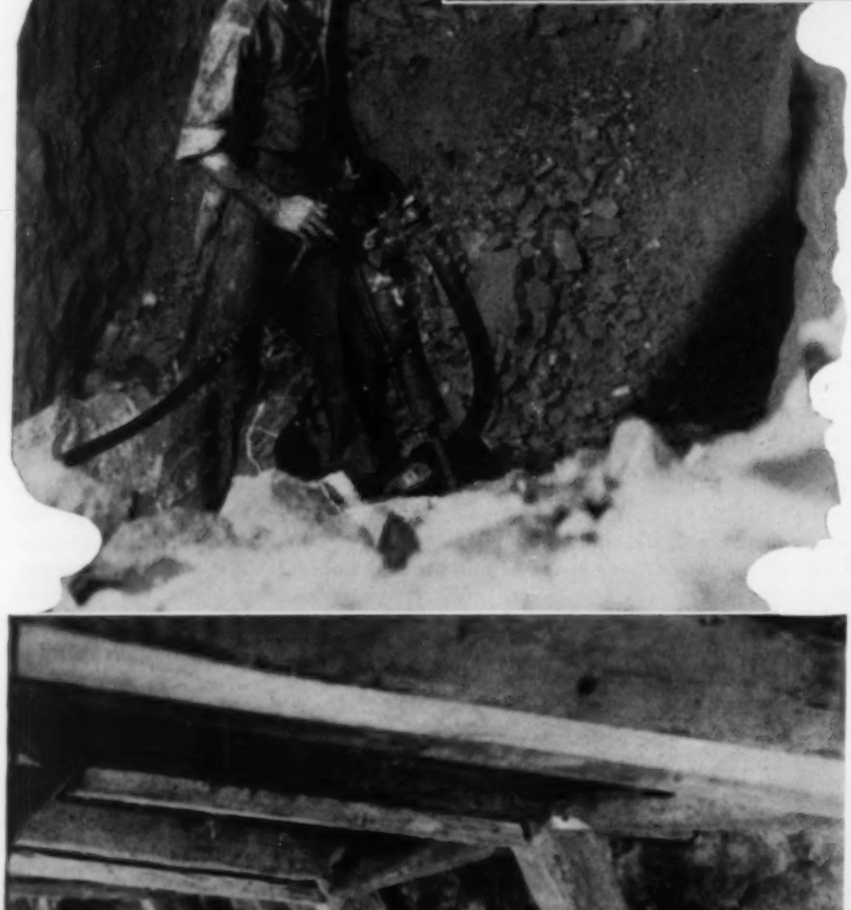
The 300-ton cyanide mill is one of the most modern in Mexico. Lime is mined and burned locally, and charcoal also is obtained from nearby kilns. Power for the mine, mill, and community comes from two hydroelectric plants located upstream from Tayoltita. Until recent years, supplies for the camp had to be transported from the river level by primitive means. Now there is a rough road that 4-wheel-drive trucks and tractors can negotiated.

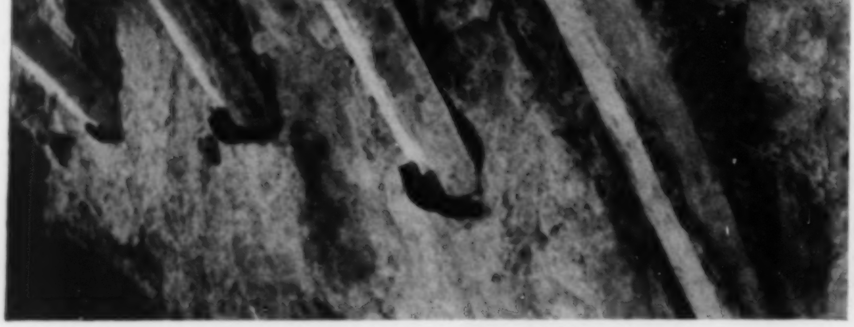
All miners live close to their work. One of the interesting customs of the country is that the men have a hot lunch brought to them from home at noon. This practice originated in Europe during the early days of mining and still persists in some sections of it. It never gained

MINING SCENES

A completed section of a transportation tunnel now being driven to tap the ore bodies at a lower level than any existing workings is shown at the right. The miner pictured below is drilling holes with an X-59 Jackhamer to break large pieces of ore at a grizzly in a stope. To conserve timber, which requires a 2-day mule trip to freight in, short angle supports resting on steel members in the walls (bottom picture) are used in some of the drifts in place of conventional longer posts.





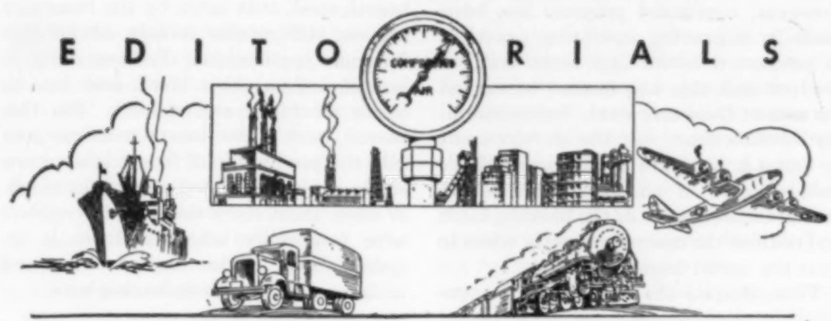


a firm foothold in the United States. At Tayoltita the lunch is carried in a bucket having a series of trays one above the other. The food is kept hot by a charcoal fire or live coals in the bottom compartment. A typical meal consists of soup in the top tray, beans in the second, meat in the third, and rice or tortillas on the plate directly over the heat. It is usually accompanied by a bottle of coffee.

Even though the area is away from the beaten path and roads have not found their way into it, Tayoltita is a modern Mexican city in all respects. It has capable doctors, hospitals, a motion-picture theater, and a bowling alley. It lies at an elevation of 1200 feet, and the climate is subtropical. During May and June, just before the rainy season, the temperature reaches 100°F. and the nights are hot. The coolest months are January and February, with temperatures ranging from 50 to 60°. It never freezes in Tayoltita. Rainfall totals 25 to 30 inches a year.

The camp site for the mine's directing personnel is beautiful. Tropical flowers are found in profusion. Poinsettias attain the size of small trees and nasturtiums, roses, ferns, and shrubs flourish. The fruits available would back most any supermarket off the map. The more plentiful varieties are mangoes, avocados, papaya, oranges, limes, grapefruit, grapes, strawberries, guava, figs, dates, pomegranates, and cocoanuts. Root vegetables do not do well, but peppers, cabbages, tomatoes, and onions grow abundantly. Other vegetables have to be shipped in. And the surrounding mountains, with wild animals and game such as lions, tigers, bobcats, opossums, deer, turkeys, and pheasants, are a hunter's paradise.

EDITORIALS



HOOVER'S SERVICE TO MINERS

IN paying homage recently to Herbert Hoover on the occasion of his seventy-fifth birthday, the nation naturally emphasized his role of statesman and humanitarian. Little was said about his earlier career as one of the world's foremost mining engineers. This chapter of his life is, however, important as revealing inherent characteristics of the man. An outstanding accomplishment during this period and one that will endure through the ages was his translation, with the help of his wife, of Georg Agricola's *De Re Metallica*, which had been written in 1556. This work not only stamped Mr. Hoover as a scholar of the first order, but also gave the mining industry a clear and comprehensive picture of its beginning.

The Hoovers' interest in the book was aroused prior to their marriage when both were students in Leland Stanford University. One of their professors had a copy of the rare volume. Ten years later they began its translation while temporarily living in London. They spent five years at the task, utilizing all their spare time and foregoing all social life during the period. Others had tried and failed before them. The chief difficulty was that the book had been written in Latin a thousand years after that language had ceased growing. The author, a physician who lived in the mining district of Joachimstal, Bohemia, and studied mining as an avocation, coined hundreds of words because none existed for some of the mining terms he wished to use.

In the course of their endeavors, the Hoovers visited the area Agricola had described, hoping to gain a better understanding of what he had written. However, the mines had long been abandoned. They then sought the aid of the faculty of the famed school of mines at Freiberg, but the professors knew little about the old mining methods. In the end, they made an exhaustive search of ancient mining and metallurgical records, gaining much of their information from second-hand books picked up in their travels to various parts of the earth. Only after they had acquired a vast knowledge of past modes of mining and treating ore could they interpret some of Agricola's passages.

Not until 1912 was the book ready for publication. Then they sought and found, in England, a printer who would reproduce it as nearly as possible like the original. A special font of type was cast, the printing was done on a hand press, and the completed volume was bound in sheepskin. The Hoovers intended originally to produce only a few hundred copies, for private distribution. Later they were persuaded to increase the number as an aid to the mining profession. They stipulated that the book should sell for $5, which was about one-fifth the production cost. They paid the difference and, in addition, distributed many free copies to libraries, museums, and mining schools. Only 3000 copies were printed and the book is now a collector's item.

Thus has been preserved a treatise which, in its original Latin, greatly influenced the course of mining in various parts of the world. For centuries it was called a "chain book," because it was bound in iron and chained to the altars of churches in mining districts. Miners seeking solutions of their day-to-day problems went to their priests, who consulted the volume and expounded on the translation. The work was used as a textbook in Germany and England during the sixteenth and seventeenth centuries and enabled the Spaniards to institute successful mining and metallurgical processes in Mexico following their conquest of that country.

Mining men and students who have had reason to peruse the fascinating Hoover translation are struck by the magnitude of the task it entailed. To them it is clear that Mr. Hoover's services to his fellow man began long before the world at large came to recognize him as a humanitarian.

BESSEMER PROCESS ENDURES

ALTHOUGH it was the first one devised for making steel on a large scale, the Bessemer process is holding its ground well against newer techniques and promises to continue to be extensively used during the foreseeable future. Originally called the "pneumatic process" because of its employment of compressed air for blowing the impurities out of molten iron, the Bessemer principle has survived for 93 years and still turns out an appreciable proportion of the world's steel.

Abroad, it is considered of such importance that a special report on it has just been issued by a subcommittee of the British Iron & Steel Institute. The document discusses current practices in Britain, Continental Europe, and the United States in great detail. It is significant to note that in 1937, the most recent year that can be considered normal from an economic standpoint, the nations of Western Europe produced 19.6 million tons of steel by the basic-Bessemer process.

While the mode of operation has remained fundamentally the same, refinements in equipment, coupled with technological advances, have largely eliminated the long-existing shortcoming of the process, namely, that it was incapable of being closely controlled and consequently of turning out a uniform product. An important improvement has been the development of means by which the sulphur and phosphorus contents of the steel can be held down. After considering these factors, the committee concluded that, so far as Great Britain is concerned, "many of the old prejudices are now without foundation in fact, and the metallurgist has to use an open mind when choosing between basic-Bessemer and open-hearth quality of steel."

In Germany, the so-called Thomas process of making steel accounted for 40 percent of the production prior to World War II and it predominated in the steel-producing sections of France, Belgium, and Luxembourg that the Nazis occupied. The Germans were thus compelled to rely upon it for most of the steel that went into their war effort, and their technologists necessarily had to take steps that would enable it to deliver a product suitable for purposes that had previously required open-hearth or electric-furnace steel. Their success led to a reëvaluation of the Thomas process as a peacetime technique. The Thomas process is a duplex operation in which the partially refined metal from a basic-Bessemer converter is further treated in an open-hearth or an electric furnace.

The outstanding advantage of such a dual process is that it cuts down the time required to make steel from pig iron and scrap. The Bessemer treatment takes only 15 or 20 minutes, as compared with 10-12 hours in an open-hearth, and 4-6 hours in an electric furnace. And, by the same token, the partial refinement in a converter permits reducing the subsequent processing by open-hearth or electric-furnace methods.

Little effort has been made in the United States to utilize the duplex process as a substitute for established open-hearth and electric-furnace practices. Our conditions and resources are such that, even under stress of wartime, we can adhere to the most suitable process available for turning out steel of a specified grade. Products that will adequately serve for many purposes can be made in the converter alone, and there are also others that can be satisfactorily turned out by duplexing. Owing to the nature of the raw materials available, only the acid-Bessemer process is used here.

There have been few if any converters added to U. S. steel plants since 1932. However, continued progress has been made in improving operating practices to produce a better and more uniform product and this has tended to extend the uses of Bessemer steel. An outstanding advancement was the development by Jones & Laughlin Steel Corporation's research men of an electric-eye device that detects changes in the blowing cycle and notifies the operator exactly when to pour the metal from the vessel.

Thus, despite the trend toward open-hearth steel, that made by the Bessemer process still retains certain advantages for some applications. For one thing, it is stiffer than other steels and can be easier machined and welded. For this reason, most of the Bessemer output goes into the production of free-cutting screw steels, skelp for welded pipe of the smaller sizes, sheet steel, tinplate, low-carbon wire (especially where stiffness is required, such as in barbed wire and nails) and concrete reinforcing bars.

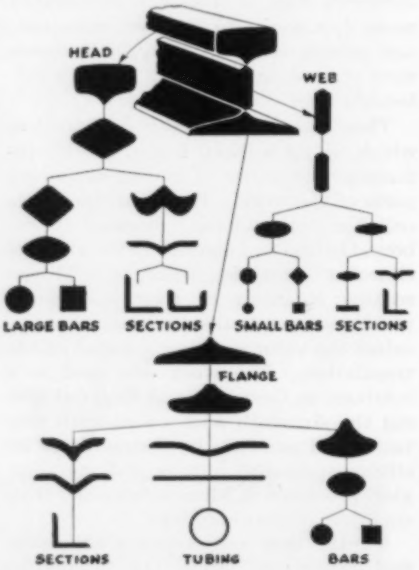
This and That

Mexico City is Sinking Some of the difficulties of founding heavy structures on the spongy clay soil that underlies Mexico City were recently told to the American Society of Civil Engineers by Pedro Albin, Jr., a construction engineer of that place. The whole plateau on which the city rests is gradually subsiding, and where buildings are over-heavy for the soil, the local settlement is more pronounced than in surrounding areas. Conversely, where supporting piles extend downward to a firm footing, the buildings remain stationary, while the land around them sinks. For example, the Independence Monument appears to grow in height as the surface of nearby streets subsides. The sidewalk around the monument's base has been relaid several times and now slopes downward toward the bordering streets. To avoid a similar difficulty in the case of a building now being erected, it will rest on screws so that it can be lowered progressively as the surrounding streets settle. One concrete structure not built on piling has settled so much in five years that its ground floor is now a foot below street level. Wooden piles as long as 112 feet have been driven to transfer the support of some buildings to a deeper, more stable stratum. Concrete piles made in the United States are being used under the new La Latina Americana Building, for which Mr. Albin is the engineer.

* * *

More About Rails As a brief sequel to *The Tail of the Rail* (May issue), we can report that the service of steel rails does not end when they are removed from the ties. Most of them go back to the steel mills to be transformed into various useful shapes. The industry designates the latter as rail steel products. The more common of them, as listed in the *Steel Products Manual* of the American Iron & Steel Institute, are hot-rolled bars and bands, bar-size shapes, concrete reinforcing bars, light rails and accessories, structural tubing, and fence-post sections. Bar-size shapes are defined as angles, channels, tees, zees, channeled flats, and U-bars under three inches in greatest cross-sectional dimension.

To quote from the publication mentioned, "As early as 1860 it became apparent to steel men that railroad rails, available from the railroads after normal track service, offered a source of hard-grade steel in a form suitable for conversion by hot rolling into bars and shapes without remelting. Since the establishment of the first mill for rerolling steel rail for commercial production, the industry has been greatly expanded by reason of the increasing supply of raw materials made available by the growth of our railroad system."



Twenty mills widely distributed throughout the United States and Canada now produce a substantial tonnage of rail steel products. When taken out of service by railroads, rails are classified as "relayers," "rerollers," or "scrap." Relayers are used for additional track service. Rerollers become the raw material for rail steel products and are purchased by the rail steel mills. Scrap rails are sold for remelting purposes.

Rerollers that pass inspection are sorted for size, cut to suitable lengths for handling, and cleaned. Pieces of uniform section are heated in a continuous-type furnace to the proper temperature for rolling. In the initial rolling pass, each piece is commonly slit to separate the head, web, and flange sections, each of which is then made into its own quota of products by a series of roughing, intermediate, and finishing passes. The rail heads end up as large bars and sections, the webs as small bars and sections and the flanges or bases as bars, tubing, and sections.

Because it is approximately 50 percent stronger than medium-carbon steel, rail steel can be fabricated in lighter-than-normal sections and still meet service requirements.

* * *

Four Miles Down The deepest hole ever drilled has reached bottom, for Superior Oil Company has ended work on its Pacific No. 1 Well in Sublette County, Wyoming, at a depth of 20,521 feet. A halt was called after 7-inch casing had been cemented at 19,765 feet to test for oil in the formations below that point. Next to the Pacific No. 1 in depth is a well in California that was abandoned at 18,734 feet in March of this year as a dry hole. During the latter stages of the drilling in the Wyoming well, the drill pipe in the hole weighed 300,000 pounds, and all of it had to be withdrawn and disconnected each time the bit was changed. All told, this was done about 200 times. The temperature at the bottom of the hole exceeded 300°F.—hot enough to make the mud boil except for the great pressure at that depth. Although the figure has not been made public, it is estimated that the dry hole cost the Superior Oil Company around $3,000,000. The first well to reach 10,000 feet was put down in 1934 and was considered a remarkable achievement. The fact that the oil industry has been able to double that footage in the intervening fifteen years speaks volumes for the advance made in drilling technique.

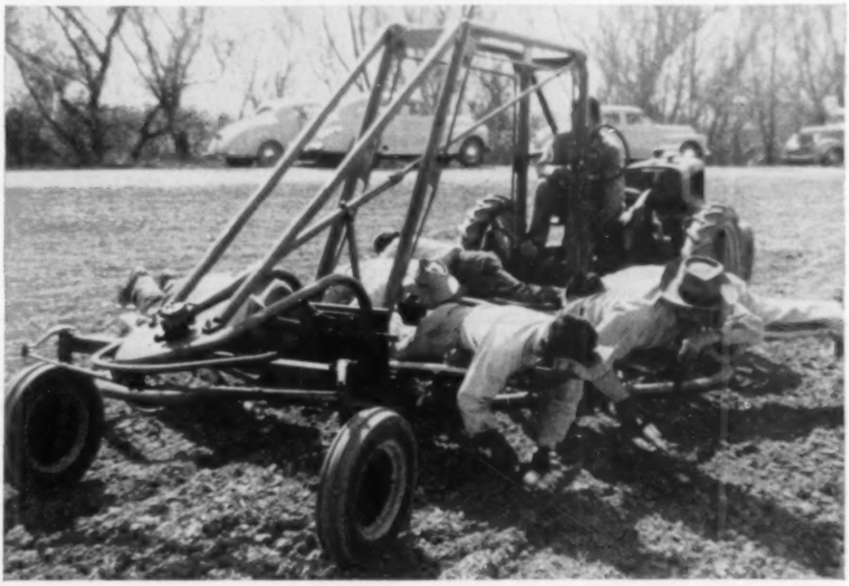
Latest Pneumatic Hoeing Rig Gives Workers Free Ride

WE have previously reported on the increasing application of air power to agriculture. Underlying reasons for the trend are the high cost of labor and the mounting resistance of hired hands to the drudgery that has traditionally characterized many farm tasks. The Pacific Coast has assumed leadership in the mechanization movement and most of the developments have so far emanated from farm workshops there.

One of the most active men in this line of endeavor is Frank King of Woodlands, Calif. He has devised numerous and diversified pneumatic appliances and implements for use on his two farms and became so interested in the possibilities in this field that he established a shop in Woodlands. From it have continued to come improved tools and machines of varied types, most of them intended for use by fruit and nut growers.

Some months ago Mr. King set out to alleviate the tedious task of hand weeding that has always been required in cultivating such crops as sugar beets. The customary procedure has been for men and women to go through the fields on hands and knees—a job so unattractive that few Americans cared to perform it. It has accordingly been the practice in some beet-raising sections to import laborers from Mexico during the growing season.

King's first pneumatic hoeing assembly consisted of a tractor-mounted air compressor with booms extending from both sides to support air lines for operating six tools. The workmen walked beside the machine as it traveled slowly along the rows. His latest creation transports the crew of six, who lie prone close to the ground, each weeding a strip of the field.



HOEING AS THEY RIDE

Frank King's latest pneumatic hoeing rig is shown at the right during its first tryout. The carriage carrying the six men is swung between the front and rear wheels of an Allis-Chalmers tractor. A portable air compressor to furnish power for the hoes is trailed behind. In the picture above, Mr. King is holding three different types of pneumatic hoes he has developed for various services.

Corncobs Clean Electrical Equipment

MOTORS, coils, transformers, and similar apparatus are being cleaned with corncobs and compressed air in the electrical shop of the sheet and tin-mill division of Carnegie-Illinois Steel Company at Gary, Ind. The operators have found that finely ground corncobs, blown onto the work by a stream of air, do a job far superior to that possible with the liquid solvents that were formerly employed for this work, and with none of the disadvantages associated with the latter.

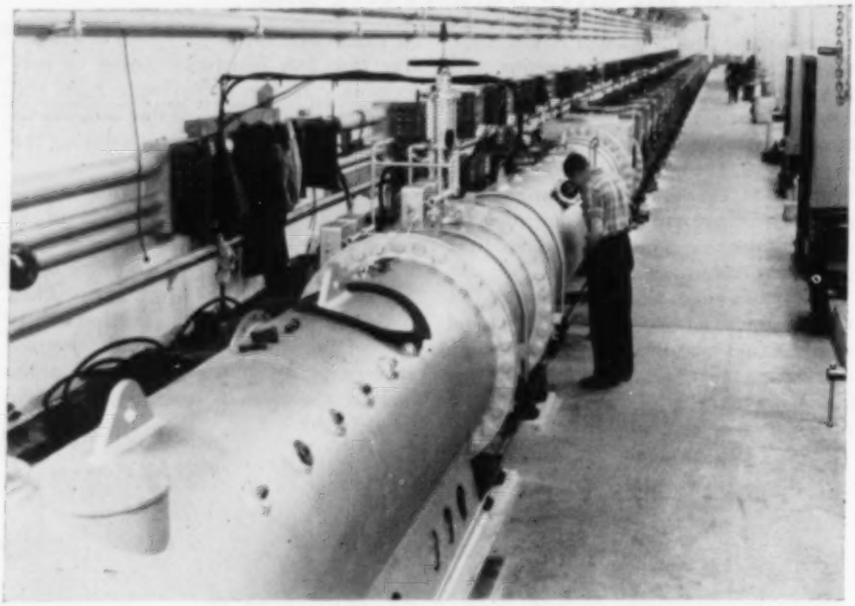
Air at a pressure of about 30 psi. is used. The granulated material is introduced into the air stream by means of a conventional-type siphoning arrangement. Emerging from the nozzle of the air hose it is blown through all openings in the armature windings and commutator assembly, where it picks up and carries away any dirt or liquid present. The rate of delivery to any particular area can be regulated by simply varying the air pressure. When the apparatus has been cleaned sufficiently, the flow of granulated material is shut off and the air stream played on the work to remove any clinging particles.

Equipment treated in this manner is said to present shining, lustrous surfaces almost like new. Because the cleaned surfaces are completely dry, it is possible immediately to reassemble and put the machine back in service.

Smokeless Fuel from Coal

CLEANER communities through smoke abatement are being sought the length and breadth of the land, and much has been done industrially towards this end by the use of overfire jets, which were described in our December, 1948, issue. Other efforts to eliminate the smoke nuisance involve the production of a smokeless fuel through the fluidization of coal. The process was invented about six years ago by Dr. A. D. Singh and consists in passing air and gases under pressure through a bed of pulverized coal in the presence of high heat. Hydrogen, carbon, and other gases are released and drawn off with the tar, leaving a solid mass of so-called char. When burned, this fuel is said to liberate large quantities of heat with a minimum of smoke, making it ideal for home and industrial use.

The early work was financed in part by the Inland Steel Company seeking a substitute for Pocahontas coal. Since then the Illinois State Commission has supported the project and has completed plans for the construction of a pilot plant, with a capacity of 2 tons an hour, at an estimated cost of $115,000 to be appropriated, together with $425,000 to run it for two years, by the Illinois State Legislature. The plant in which Doctor Singh conducted his experiments produced 100 pounds hourly and used coal from the Peabody field in central Illinois, which is suitable for the fluidization process and of which an unlimited supply is available. Besides promoting the state's smoke-abatement program, the operations have another aim—to find more and better uses for coal and to convert waste into useful products.



CAPTURED NAZI SUPERSONIC WIND TUNNEL

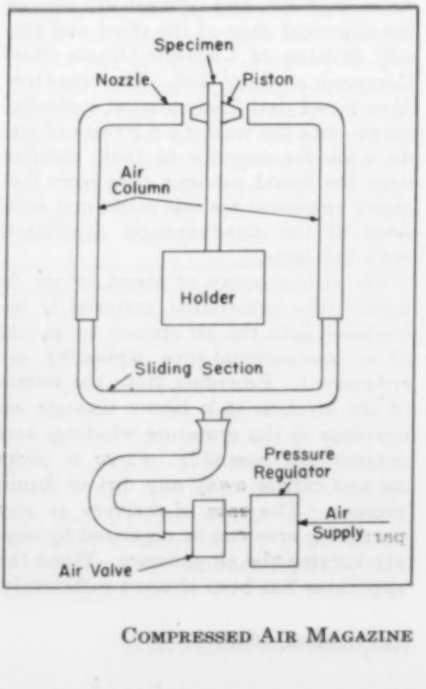
Now used by the U. S. Navy at White Oak, Md., for ballistic tests, this 287-foot-long steel tube served the Germans during the development of their V-2 rockets. It was taken over by the Allies as a war prize in 1945. In it, projectiles are tested under varying simulated pressures and can be photographed through the window into which the man is looking. Navy Ordnance laboratory scientists have already achieved conditions in the tube equivalent to 5.18 times the speed of sound.

Pneumatic Fatigue Tester for Metals

ACCELERATED fatigue testing of metals by reverse bending is possible with a pneumatic device manufactured by General Electric Company, according to the July, 1949, issue of *Machine Design*. Consisting essentially of a "tunable" air column, which vibrates the part being tested and the length of which can be adjusted to the natural frequency of the part, the apparatus can handle specimens or finished work having resonant frequencies of 50 to 300 cycles a second, with amplitudes of vibration up to ½ inch on the free end.

In use, the part is placed vertically between the two opposing ends of the air column, with the lower end held firmly and with a small piston fastened to each side of the free end. Nozzles at the ends of the air column are then adjusted so as to leave clearances between them and the pistons. Next, pulsating air is turned on, causing the specimen to vibrate at its resonant frequency. The length of the pneumatic column is then adjusted by means of a sliding piece until the free end of the test part undergoes maximum displacement, which occurs when the air column and the specimen are at the same frequency. Seven of these trombone-shaped sections are provided to cover a wide range of frequencies.

Gas-turbine blades and other parts that must perform well at high temperatures can be tested under simulated operating conditions by the aid of an electrically heated furnace. The vibration of the specimens at their natural or resonant frequency, in combination with heat, makes for destructive tests of short duration. Because the air impulses are amplified by operating the device at the natural frequency of the vibrating part, little air is needed.



Vending Machine Domes Formed by Compressed Air

COMPRESSED air and a surplus pneumatic press are being utilized by the Texas Engineering & Manufacturing Company to effect a 57 percent reduction in the costs of forming transparent domes for popcorn vending machines. The domes are made from 24x20-inch sheets of 0.250 Plexiglas and were formerly fabricated by an outside manufacturer using a vacuum and shrinkage process. They are 11¼ inches high and have a 16¼-inch-square base with a ¼-inch-wide mounting flange.

POPCORN VENDOR

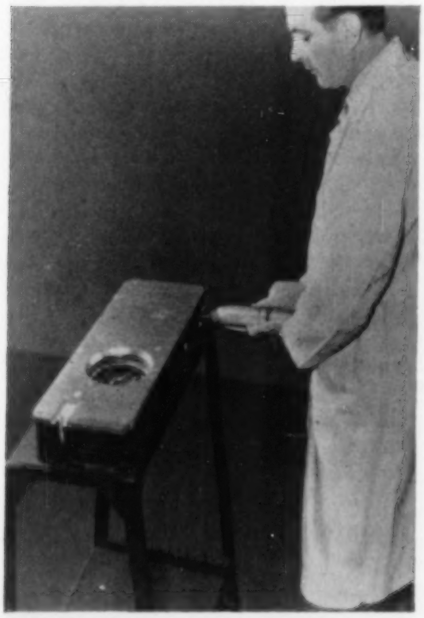
Popcorn wagons were once familiar sights on city street corners and in amusement parks. Now popcorn is automatically dispensed by some 30,000 machines such as this one. Compressed air helped to form its Plexiglas dome.

By the new method, a Kirksite holding die, the interior measurements of which conform exactly to the exterior dimensions of the finished dome, is mounted on a light-duty pneumatic press along with an aluminum-faced Masonite punch 4⅜ inches deep and with an inch clearance on all sides. When in use, the die is heated with a torch and the inside surfaces are coated with a fibrous grease. A preheated sheet of Plexiglas is then laid on the die and the punch lowered to partially shape the dome. At the bottom of the stroke, the punch bed forces the edges of the sheet against the die to effect a seal. Compressed air at 50-55 psi. pressure is then introduced through an opening in the punch to complete the forming of the dome. Surplus grease, driven out through drain holes in the sides of the die by the expanding Plexiglas, is caught and filtered for reuse.

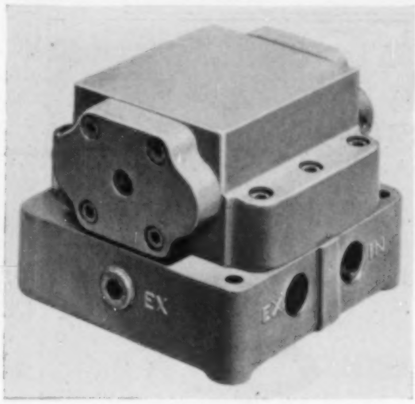
One man carries out the entire operation, turning out 40 to 50 finished domes in an 8-hour shift. The handwork of flattening the flange has been eliminated, while rework necessary because of cracks, scratches, improper wall thicknesses, and other imperfections has been reduced to a minimum. Whereas rejections were running 10 percent or more by the previous forming method, only one dome of the first 400 made by the new process was found to be faulty.

Industrial Notes

What is claimed to be the first device for testing the tightening capacity, range, and adjustment of electric- or air-powered torque tools before use or while on the line has been developed by Richmond, Inc. Designated as the Livermont Analyzer, it is a direct-reading gauge mounted on a stand with casters for portability. Operated mechanically, it requires no power connection, and each unit is provided with a master torque wrench so that accuracy can be checked periodically. Machine can be reset in a matter of minutes, if necessary, thus obviating its return to manufacturer for recalibration. It eliminates the human factor that results in highly variable assemblages and makes it possible to maintain a predetermined standard in tightening nuts, bolts, and screws. On direct drives, states Richmond, Inc., it shows the torque at which the clutch releases and at what rate torque increases beyond the releasing point when held in engagement. On cushion-clutch drives it indicates at what torque the clutch releases and begins to impact, the rate of torque gain after impact starts, and the ultimate torque capacity of the tool. In the case of pure impact, it reveals the power-delivering capacity of the latter, the time required to reach a certain torque, and the tool's ultimate torque capacity.



Hanna Engineering Works has developed a new 4-way Mastair Valve of the balanced spool type that may be controlled by one 4-way or two 3-way pilot valves. It is described by the manufacturer as a control unit of high efficiency, to which the following features contribute: Few fittings are needed because of straight-line piping; pipe may be connected to the bottom or sides, as desired; and spool and sleeve assembly is easily taken out by removing end caps. Available in pipe sizes of ⅜, ½, ¾, and 1 inch with cam, lever, pushbutton, or foot-operated pilot valve. Parts in any size are interchangeable.



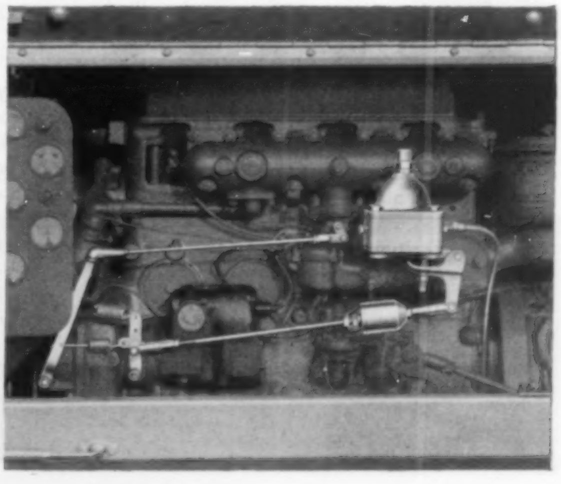
Southern yellow pine and Douglas fir treated with Copperized CZC is offered by Koppers Company which has developed the chemical in coöperation with E. I. duPont de Nemours & Company, Inc. The lumber is intended primarily for use above ground and is said to resist rot and termites. It is obtainable in small quantities or carload lots.

Ansco, a division of General Aniline & Film Corporation, is making preparations to distribute its new color film suitable for use in ordinary low-priced cameras. It has been named Plenacolor and is being made in 120 and 160 six-exposure roll-film sizes. Processing and printing will be handled through Ansco dealers.

Samples can be obtained of a new insulating material made by Owens-Corning Fiberglas Corporation in blanket form for thermal and acoustical applications. Called Fiberglas Aerocor, it comes in 200-foot lengths from 18 to 72 inches wide and ½ to 2 inches thick, but manufacturer will slit it for customer to any width between 2 to 6 inches. It is said to have an effective temperature range from subzero to 600°F., and to show greatest efficiency in the middle and high-frequency sound levels. Intended primarily for heating, air-conditioning, and refrigerating systems, automotive vehicles, etc., it may also be used to line clothing.

A tinning compound for which exceptional properties are claimed has been put on the market by Farrelloy Company. A powdered solder containing flux, it is said to be strong enough to remove scale and dirt and to tin rusty surfaces thoroughly without producing harmful fumes and injuring the skin. It may be applied with a torch or soldering iron, depending upon the thickness of the metal. Designated as Farco Tinning Compound, it can be used to tin aluminum, cast-iron water jackets and cylinder heads, cast-steel bearings and pipes, stainless-steel equipment, etc.

For portable compressors, Ingersoll-Rand Company has announced an improvement in its multispeed Drill-More regulator, which has been in use since 1939. Like the original model, the Floating-Speed UL-83 automatically varies the speed by adjusting the engine governor spring, but it is easier to adjust and simpler in its operation. The claims made for it, as compared with other capacity-control regulators, are: Fuel savings up to 40 percent by preventing wasteful idling and by always compressing the needed air at the lowest possible speed; maintenance of higher average air pressures (15 to 20 psi.), thus increasing the productive capacity of pneumatic tools; and less engine and compressor upkeep because of lower average compressing speeds and fewer unloadings. Additional features stressed by the manufacturer are: Elimination of speed steps and cycling because speed "floats" up or down to the exact point desired as air requirements change; compressor loads and unloads at low speed; and standard setting insures full rated pressure at full capacity. Detailed information about the new Drill-More regulator is contained in a folder—Form 2033—which can be obtained from the company's main office at 11 Broadway, New York 4, N. Y., or its branches.



What is said to be the world's largest marine-type Diesel-electric drilling rig will be supplied with power from a floating plant recently completed by Westinghouse Electric Corporation. The drill, mounted on a barge 175 feet long and 70 feet wide, will be used to tap oil formations under Lake Maricaibo in Venezuela and will be operated by current generated by three 400-kw. direct-current generators. For lighting and other auxiliary loads the powerhouse carries four 75-kw. generators.

Bell Laboratories are responsible for the statement that such a thing as an erroneous telephone charge just won't be possible when exchanges are equipped with its ingenious automatic telephone accounting machine. It records the caller, the local or long-distance telephone called, the date, and the duration of the conversation to an accuracy of a tenth of a minute on a roll of paper 3 inches wide and long enough for 25,000 calls. The perforated tape is inserted in a reader—a machine that assembles, translates, sorts, and prints the summary in a form for billing subscribers. The first installation is in the Media, Pa., exchange.

A precision meter measuring air velocity in two ranges—from 0 to 400 and 400 to 6000 feet—has been announced by the Hastings Instrument Company, Inc. It is based on a combination of the hot-wire and thermopile principles, an arrangement that is said to increase accuracy by eliminating errors attributable to temperature changes. The output is suitable for remote indications and operation of a standard strip or circular-chart electrical recording instrument. Meter may be used for measuring air velocities in ducts and flow in air or gas lines, in surveying heating and air-conditioning systems, for process control, and in connection with meteorological studies. Illustration shows instrument complete with a Tee-section pickup probe.

If you have use for a standard screw and wire pocket gauge you may obtain one free of charge by writing to the Dayton Rogers Manufacturing Company, on Thirteenth Avenue, South, Minneapolis 7, Minn. It indicates the size of either wood or machine screws from Nos. 0 to 14 and measures diameters from 1/32 to 1/4 inch. Request for the gauge should be made on company letterhead.

Among the new foundry materials introduced recently is a synthetic-resin core binder made by Interlake Chemical Corporation under the name of Ibon. It is said to speed the baking cycle without excess oven temperature and with negligible gassing during the baking operation or during the casting cycle.

Here's the *Proof* of Preference for WISCONSIN HEAVY-DUTY *Air-Cooled* ENGINES

✓ 4 Out of 10 Carburetor Type Engines made in 1947 in 2 to 30 H. P. Range were WISCONSINS!

According to an official bulletin issued on April 22, 1949 by The Bureau of Census, Dept. of Commerce (Preliminary Industry Report, Series MC-31D, covering the production of Internal Combustion Engines for the year 1947), 40.2% of all carburetor type engines within a cu. in. displacement range from 11.0 to 175.9 were Wisconsin Air-Cooled Engines.

The summary includes data received by the Census Bureau from 134 engine manufacturers. The tabulation of the 9 groups within the above displacement range, does not include automotive, aircraft, and outboard marine engines, built for resale as separate power units or engines for use as original equipment by manufacturers.

These figures speak for themselves . . . in terms of outstanding preference for Wisconsin Air-Cooled Engines among power users in all fields.

WISCONSIN MOTOR CORPORATION
World's Largest Builders of Heavy-Duty Air-Cooled Engines
MILWAUKEE 14, WISCONSIN, U. S. A.
Cable Address: "WISMOTORCO"

For workers who cannot take plain salt because it induces stomach distress and nausea, there has been prepared a tablet that causes the salt to enter the system at a controlled rate, it is said. Each grain in the tablet is coated in the process of manufacture so that some salt is released immediately after taking but not enough to cause discomfort. Called Pep-Up, the tablets are made by United States Safety Service Company, 3611 Broadway, Kansas City 6, Mo.

Packaged water, gas, or air lines of light weight, complete for temporary installation, are offered for rental or sale by the Albert Pipe Supply Company, Inc., Brooklyn 11, N.Y. Known as the Speed-Lay Pipe System, it consists of 20-foot lengths, from 2 to 6 inches in diameter, with ends machined to take Victaulic couplings; fittings to meet any requirements; and easily assembled valves. Piping is designed for a maximum pressure of 150 psi.

After 2½ years of experimenting under actual operating conditions, Goodyear Tire & Rubber Company has scheduled production of a new type of conveyor belt in its Coal-Flo line for underground mining. Conveyors in this service are subjected to severe flexing because of the small pulleys commonly employed, causing considerable wear and tear. To overcome this, the carcass of the new product is made of 4-ply rayon, a material that is thinner and lighter than the fabrics generally used for the purpose. In addition, its greater strength is said to permit spacing pulleys farther apart, thus reducing the number of transfer points and drives. The belting is treated to resist mildew and to neutralize acids It is available in standard widths—26 and 30 inches. The accompanying picture shows a test section carrying coal in the Bolair Mine of the Pardee & Curtin Lumber Company.

New Books and Industrial Literature

Elements of Diesel Engineering, by Orville L. Adams, has recently been published by The Norman W. Henley Publishing Company. Written as an elementary introduction to the diesel engine, the book covers in a thorough manner the basic principles of stationary-, marine-, automotive-, and locomotive-type diesel engines. Some of the subjects taken up are fundamental engine cycles; mechanics of fuel injection and combustion; the testing, rating, and performance of diesel engines; fuel and lubricating-oil systems and specifications; power losses and operating troubles; and supervision and maintenance. Containing a selection of important questions, answers, and problems on each subject covered, and illustrated with more than 200 tables, diagrams, etc., the book is equally suitable for classroom use and home study.

The author has had considerable experience in his field. He has served, respectively, in the following capacities: Research engineer concerned with the design and construction of diesel engines; ship-repair officer for the U. S. Navy during World War II, when he was charged with the maintenance and repair of a fleet of diesel-powered mine-sweepers, tugs, patrol craft, and other auxiliary ships; and instructor in diesel engineering to naval, military, and civilian personnel. The book is a second edition of a work previously published under the same name but has been brought up to date by the re-writing of more than 90 percent of the earlier edition.

Elements of Diesel Engineering sells for $5.00 and may be obtained from the publishers at 17-19 West 45th Street, New York, N. Y.

Air-Maze Corporation, 5200 Harvard Avenue, Cleveland 5, Ohio, offers a free bulletin, Form FLC-749, giving information helpful in the filtering of air and liquids. Intended for use by those concerned with the building, operation, or maintenance of engines, compressors, air conditioning and ventilating equipment, and other devices making use of air or liquids, it describes the construction and operation of the following products: Air-filter panels and water eliminators, oil-bath and oil-wetted air filters, electrostatic precipitators for air, filters for oil and fuel, screen- and electrostatic-type oil separators, air-intake and filter silencers, spark arresters, breather filters, and pipeline filters.

An alternating-current motor that can be given an infinite number of speed settings by an eddy-current clutch is described in Bulletin 611-D of the Louis Allis Company, 427 East Stewart Street, Milwaukee 7, Wis. Called the Ajusto-Spede, the motor runs on a new eddy-current principle that does away with the usual motor-generator set or exciter. It operates directly from a 2- or 3-phase line and provides a variable-speed output with a constant torque characteristic. Available in ratings of from 1 to 75 hp., the motor is especially suitable for driving such variable-speed machines as calenders, printing presses, paper and metal slitters, and conveyors. Copies of the bulletin will be sent upon request.

Aluminum pipe fittings that permit the making of pipe structures without threading or welding are described in a brochure obtainable from Reynolds Metal Company, 2500 South Third Street, Louisville 1, Ky. Of the slip-on type, the fittings are held in

"VIC" TELLS HOW

THE *ALL-VICTAULIC*
LINE LEADS TO
L-O-W PIPING COSTS!

Vic Victaulic
Sizes—¾"
through 60"

Want *minimum* piping costs, and a *permanent* solution to piping problems? . . . Victaulic Couplings, Victaulic Full-Flow Elbows, Tees, and other Fittings are your answer!

A complete VICTAULIC Piping System will save you hours of extra work . . . and lots of extra dollars. All-Victaulic Installations can't be beat for on-the-spot flexibility and all 'round simplicity!

Engineered for quick assembling and leak-proof dependability . . . that's Victaulic Couplings and Fittings. A simple two-bolt design for quick and easy hook-ups . . . a standard T-wrench is the only tool you need for making connections. Here's modern piping simplicity with long-lasting, positive-locked joints that will stand up under extreme pressure, vacuum, or strain conditions.

ALSO for fitting those pipe ends the easy - to - use "Vic-Groover" grooves 'em *automatically* in *half the time* of a conventional pipe threader!

WRITE TODAY for these 2:
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*"Vic-Groover" Catalog No. VG-47.

FOR FULL ECONOMY...MAKE YOUR PIPING SYSTEM ALL VICTAULIC!

SELF-ALIGNING PIPE COUPLINGS
VICTAULIC
EFFICIENT FULL-FLOW FITTINGS

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EXTRA SAFETY through exclusive Lockseam Spiralweld structure.
STANDARD WEIGHT ENDS for easy installation.
GREATER CONFORMITY to terrain.
SAVINGS in steel, transportation and handling.
SIMPLIFIED CONNECTIONS through exclusive Naylor Wedge-Lock one-piece couplings.
Sizes from 4" to 30" in diameter—thicknesses from 14 to 8 gauge.

Only
NAYLOR PIPE
Gives You All These Advantages In Mining Service

Naylor Pipe is now available for your requirements in ventilating lines, high and low pressure air and water lines, hydraulicking, de-watering, suction and tailings lines. Combined with the Wedge-Lock Couplings, Naylor Pipe provides the most practical answer to your piping needs. Send specifications for quotation.

Naylor Pipe

NAYLOR PIPE COMPANY
1245 East 92nd Street, Chicago 19, Illinois
New York Office: 350 Madison Avenue, New York 17, N. Y.

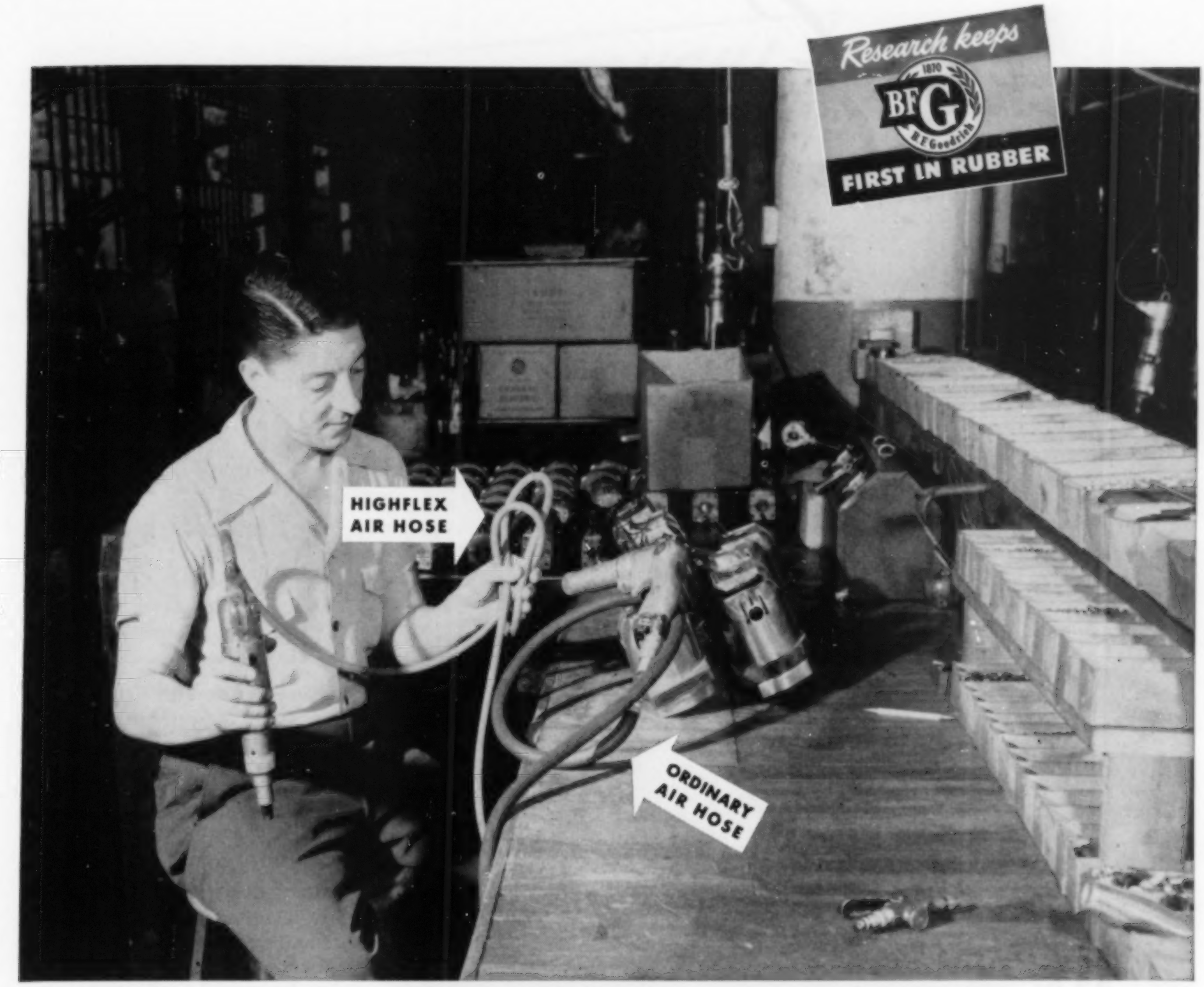
place by means of two hollow-point screws recessed in each reinforcing rib. There are three basic units from which fourteen different arrangements can be made. Many new and unusual structures, as well as practically all conventional types, can be produced by combining the fittings with aluminum pipe. Suggested uses include deck, hand, stair, and guard rails, playground equipment, car ports, portable scaffolds, and supports for canopies.

Bulletin No. CW-3 of Mine Safety Appliances Company, Pittsburgh 8, Pa., describes a new type of oxygen-administering apparatus for use in hospitals, dispensaries, offices, or homes for treating patients suffering from gas or drug poisoning, shock, pneumonia, congestive heart failure, coronary thrombosis, asthma, etc. The unit furnishes oxygen on a demand-regulated basis, a special valve actuated by a patient's breathing being used to vary the amount of oxygen fed to the mask. A high-pressure reducing valve lowers the pressure of oxygen drawn from a standard tank from 2100 to 35 psi. and is so constructed that it will safely vent the pressure if it ceases to operate. A valve is also provided for intake of outside air if the oxygen supply is accidentally terminated. The unit is readily portable, weighing less than 6 pounds complete and being furnished in a metal carrying case.

Mead Specialties Company has issued a 48-page industrial air-power catalog which describes air-operated clamps and other workholding and handling devices, and tells how their application to industrial operations can save man-hours, increase production, and lighten the machine operator's load. Included are discussions of burring machines, impact hammers, work feeders, collet fixtures, air presses and vises, midget-size air clamps, air cylinders, and pneumatic timers. Also described is a new model of the company's rotary work feeder which permits the simultaneous performance of two or more operations on small pieces of work by drill presses or other machines with no attention by an operator except to load parts. The catalog will be sent upon request to the company at 4114 North Knox Avenue, Chicago 41, Ill.

"The ABC of Large Induction Motors" is the title of a special 32-page issue of *E-M Synchronizer*, published by Electric Machinery Manufacturing Company, Minneapolis 13, Minn. Prepared by the company's engineering staff, the booklet covers the basic theory, characteristics, operation, and control of large squirrel-cage and wound-rotor motors in a variety of industrial applications. Graphs, cutaway views, and photographs used to illustrate the text make the publication a comprehensive and practical source of information concerning the installation and operation of such motors.

Vertical-propeller pumps are described and discussed in a bulletin obtainable from Ingersoll-Rand Company. The pumps, designed for the handling of large capacities at low heads, are of either axial- or mixed-flow types. Class APS pumps are single-stage units employing an axial-flow impeller and made in sizes to deliver from 2500 to 50,000 gpm. at heads up to 25 feet. They can be furnished with adjustable-vane inpellers for service where variable head and capacity conditions are found. Class APM pumps are of the mixed-flow type which combine the characteristics of both axial- and centrifugal-flow types. They are suitable for use where capacities range up to 100,000 gpm. and where heads reach to 50 feet. For higher heads, 2-stage units can be furnished. Copies of the bulletin—Form 7209—can be obtained from the company at 11 Broadway New York 4, N. Y., or any of its branches.



New hose "light as lamp cord" cuts weight 50%

B. F. Goodrich hose doubles flexibility, ease of handling

HERE'S an air hose specially designed for the most efficient use of all small air tools. Twice as light, more flexible, it allows greater freedom of movement, makes it easier to get in and out of tight corners, lets you use full pressure with your tools.

50% less weight—Now you can have a lightweight line that is adequate for the pressure the tool requires. 100 ft. of the new Highflex air hose weighs 8.8 lbs. in the ¼" size; ordinary hose weighs 20 lbs. And all sizes of Highflex give you substantially similar savings.

More flexibility—The higher flexibility of Highflex makes tools easier to use in close quarters, for hard-to-get-at jobs. Highflex cuts worker fatigue, speeds up all operations, because there is less line to drag about and keep free.

Full tool pressure—Highflex has a high margin of safety for any small air tool —250 lbs. working pressure. Single ply, double braid construction. Low expansion under pressure, minimum contraction of length.

Oil won't harm it—Tools wear out quickly when not properly lubricated. With Highflex on your tools, you can lubricate them properly without fear of oil causing hose to swell and flake, cutting air volume or jamming the tool. Highflex is completely oil proof —dragging it through oil won't damage the cover.

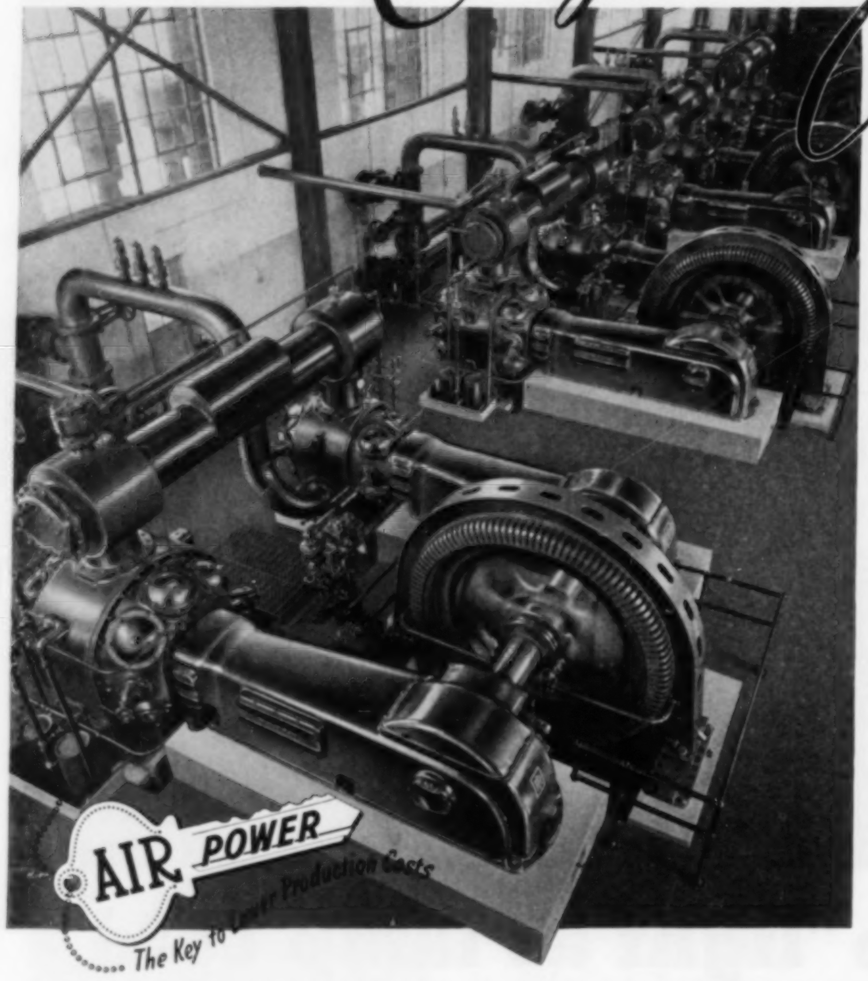
Other Highflex features—The high visibility of its red cover makes Highflex easy to keep in sight and unsnagged. Cover resists checking, snagging, and abrasion. Takes up less storage space when coiled. Ask your BFG distributor to show you Highflex air hose. *The B. F. Goodrich Company, Industrial and General Products Division, Akron, Ohio.*

Air Hose
BY
B.F. Goodrich

BACK OF *Every* INGERSOLL-RAND *Compressor*

ARE THESE

SupIRvalues



This 2800-horsepower installation of Ingersoll-Rand *Class PRE Compressors* generates the Air Power for one of America's outstanding metal mines. It is typical of thousands of similar heavy-duty compressors that are so essential in practically every industry.

Whether they supply Air Power for Air Tools in factory, mine, or construction work, or compress hazardous gases at extremely high pressure in a costly process, the purchaser must rely upon the experience and judgment of the manufacturer for a dependable compressor that meets his specific requirements. To make sure you get the best, select an Ingersoll-Rand Compressor... backed by *SupIRvalues*

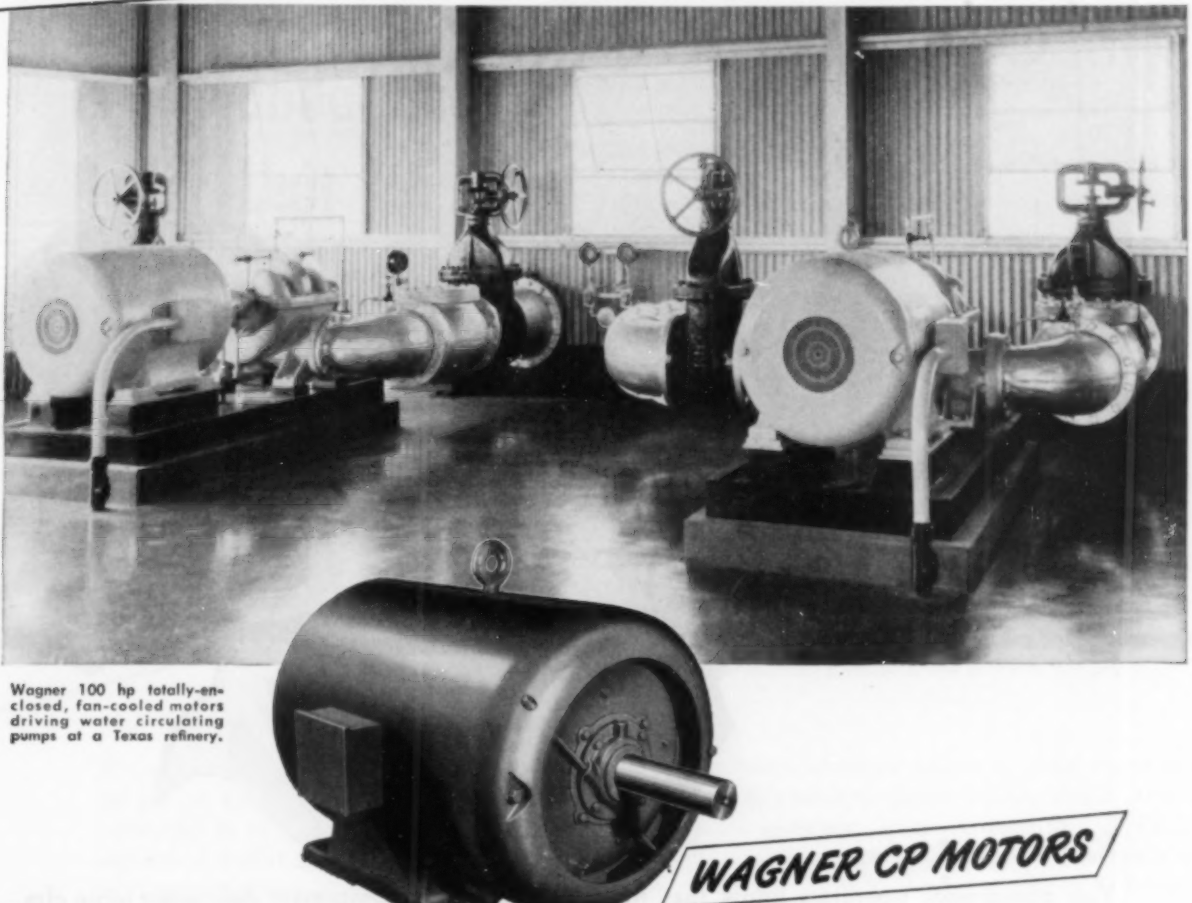
- **Tradition**...a 77-year old company that grew from the *two of the earliest* compressor builders in America.
- **Experience and Know-how** to build compressors for *any* pressure, *any* gas, *any* size, *any* service.
- **Facilities** *second to none*... for design, research, metallurgy, and manufacture.
- **Range of sizes** . . . with *standardized* frames, running gears and interchangeable cylinders ... plus *special* cylinders, valves and coolers for special applications.
- **Flexibility of Drive** . . . a *choice* of compressors powered by electric motor, oil, gas, or steam.
- **Record of Performance** ...thousands of compressors successfully operating in *every* branch of industry.
- **Design Features** that give you the best in efficiency, durability, dependability, easy operation, and low maintenance.
- **Trained Personnel** ...men who *know* Air Power...who build, sell, and service air drills and tools as well as compressors.
- **Progressive Policy**...*continuous* pioneering and development of both new and old products.
- **Service** ...with offices in principal cities *all over the world.*

Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y. 267-1

COMPRESSORS · ROCK DRILLS · AIR TOOLS · BLOWERS · PUMPS · ENGINES · HOISTS · VACUUM EQUIPMENT

Pretty... but oh so TOUGH!



Wagner 100 hp totally-enclosed, fan-cooled motors driving water circulating pumps at a Texas refinery.

WAGNER CP MOTORS

Don't let their neatness fool you. These 100 hp Wagner totally-enclosed, fan-cooled motors do a giant-sized job—driving water circulating pumps at a Texas refinery.

Motors that drive pumps and compressors find the going tough. They must overcome back pressures set up by fluids or gases—they are often required to make repeated starts and stops—they are sometimes kept in continuous service.

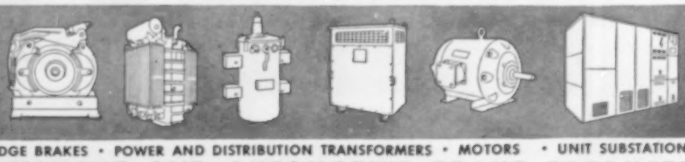
But Wagner Motors can take it. There is a Wagner Motor correctly engineered to meet the requirements of every type of pump or compressor. You can choose the motor to fit your need from the wide variety of types and sizes in the Wagner line. Bulletin MU-185 gives full details.

Buyers of Wagner Motors get Nationwide Service! More than 450 Wagner Authorized Electrical Service Stations and Parts Distributors *plus* 25 Wagner-owned Service Branches are ready to immediately supply on-the-spot service, factory guaranteed exchange motors, or genuine Wagner parts. Write for Bulletin MU-24 for complete list.

Wagner Electric Corporation
6418 PLYMOUTH AVE., ST. LOUIS 14, MO., U. S. A.

Consult Wagner Engineers on all Electric Motor Problems

Wagner
Electric Corporation
EST. WEC 1891

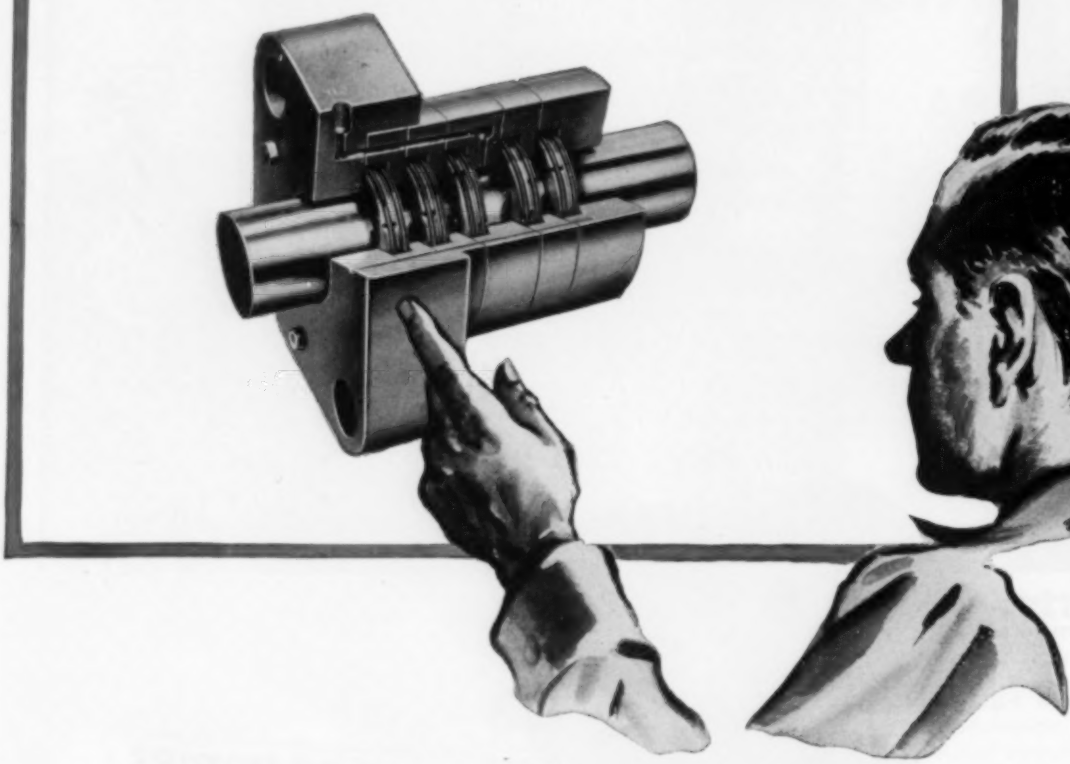


BRIDGE BRAKES • POWER AND DISTRIBUTION TRANSFORMERS • MOTORS • UNIT SUBSTATIONS

M49-17

ELECTRICAL EQUIPMENT AND AUTOMOTIVE BRAKE PRODUCTS

Cut the High Cost of Friction with COOK ROD PACKINGS



You compressor operators know that friction-induced wear reduces compressor efficiency and adds to operating and maintenance costs.

Realizing this, more and more operators insist on using Cook Metallic Packing in their compressors. Cook Packings cut friction to a mere fraction. The packing rings "float" with the rod, automatically compensating for misalignment and vibration and avoiding the friction and wear that might otherwise occur. Their design also insures a constant oil film between the rod and packing rings, eliminating metal-to-metal friction.

Precision built of the finest wear-resisting and wear-retarding materials, Cook Packings assure a long-lasting pressure seal that keeps your compressor delivering more cfm at less cost for longer periods.

Next time you order equipment, it will pay big dividends to specify Cook Packings—they're designed to cut the high cost of friction and maintain high operating efficiencies. For existing equipment, write us direct.

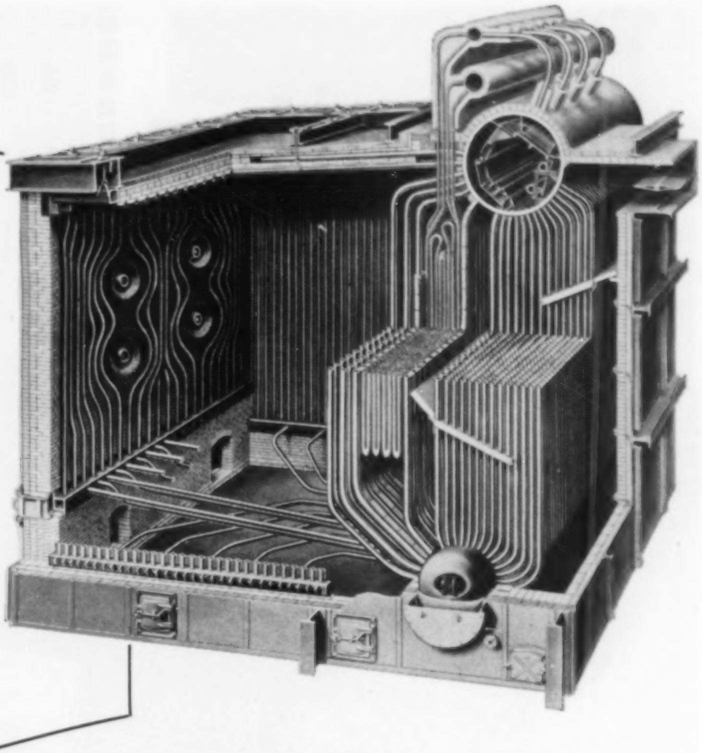
C. Lee Cook Mfg. Co., Louisville, Ky. Branch offices in: Baltimore, Boston, Chicago, Cleveland, Houston, Los Angeles, Mobile, New Orleans, New York, San Francisco and Tulsa.

COOK

ROD PACKINGS

. . . SEALING PRESSURES SINCE 1888 . . .

is a standardized Boiler Unit the Best Answer for your steam needs?



C-E Vertical-Unit Boiler, Type VU-50. This unit may be fired with coal, oil, gas or any combination of these fuels. Furnace bottom may be as shown or of the hopper type. Other VU designs are available that are suitable for virtually any type of mechanical stoker as well as for oil and gas.

If your capacity requirements fall within the range of the Vertical-Unit Boiler (10,000 –350,000 lb of steam per hr), very likely the answer is YES! And this is true even though your combination of load, pressure, temperature, fuel and space conditions may pose a problem different from that of any other plant in the country. The reasons for the adaptability of Vertical-Unit Boilers to widely varying conditions may be simply stated:

FIRST – let's take load, pressure and temperature conditions. VU Units are in service – many for more than 10 years – operating at a variety of steam pressures up to 1,000 psi and at temperatures to 900 F and above. They are meeting load conditions that vary from the widely fluctuating demands of certain process industries to the above-capacity requirements of overloaded steam plants.

NEXT – let's consider your fuel situation. The VU family is versatile. No matter what fuel – oil, gas or coal, alone or in various combinations – the VU furnace design is adaptable to the most suitable type of firing equipment.

AND FINALLY – let's take a look at physical layout, i.e., space conditions. With the integral, water-cooled furnace in front of the boiler surface instead of below it, head room is seldom a problem. Since width, depth and distance between drum centers are variable in standard increments, virtually any space situation can be met. And you can have deep ash pits or shallow as required, economizer and/or air heater surface if necessary.

Industry – world-wide – has purchased units of the VU family with an aggregate capacity of nearly 100,000,000 lb of steam per hr. So you can select a VU Unit with confidence that you will get all the economic benefits of service-proved, standardized design in an installation suited to your particular conditions.

B-331

C·E

COMBUSTION ENGINEERING– SUPERHEATER, INC.

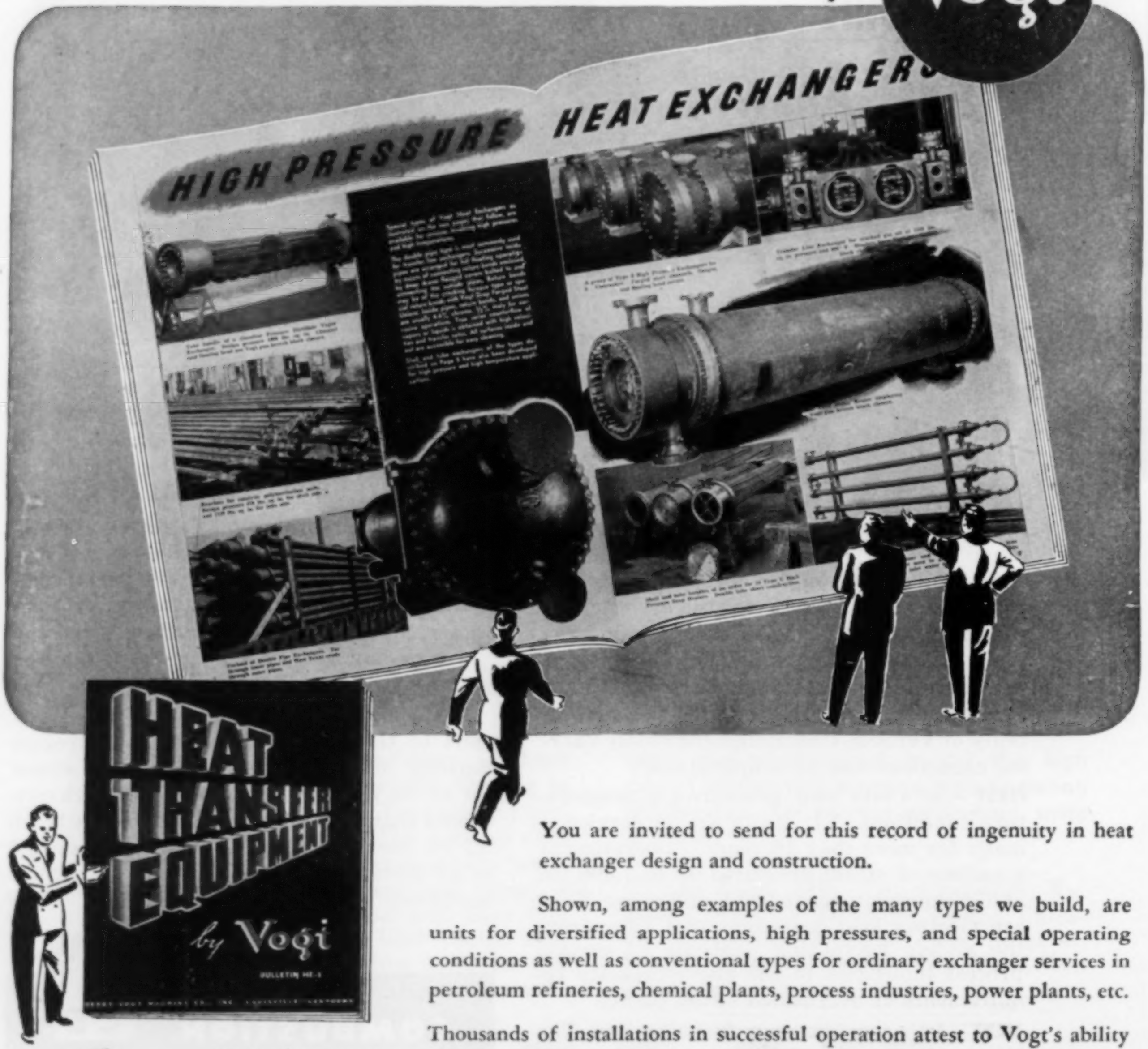
A Merger of Combustion Engineering Co., Inc. and The Superheater Co.
200 Madison Avenue • New York 16, N. Y.

ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS.

Presenting

a pictorial record of standard and special built HEAT TRANSFER EQUIPMENT

by Vogt



You are invited to send for this record of ingenuity in heat exchanger design and construction.

Shown, among examples of the many types we build, are units for diversified applications, high pressures, and special operating conditions as well as conventional types for ordinary exchanger services in petroleum refineries, chemical plants, process industries, power plants, etc.

Thousands of installations in successful operation attest to Vogt's ability to give effective help in the solution of heat transfer problems peculiar to a wide variety of operating conditions.

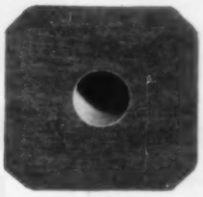
Write for a copy of Bulletin HE-5, on your letterhead.

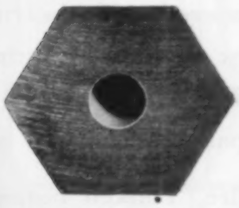
Vogt
FOR BETTER HEAT EXCHANGERS

HENRY VOGT MACHINE CO.
INCORPORATED
LOUISVILLE 10, KENTUCKY
BRANCH OFFICES: NEW YORK, PHILADELPHIA, CLEVELAND, CHICAGO, ST. LOUIS, DALLAS

every lot

service tested





Crucible Hollow Drill Steel stands up under the severest field operating conditions. That's to be expected, because *every lot* is given an accelerated fatigue test, correlated with *actual granite drilling*, before shipment.

Controlled hardenability, excellence of stress-bearing surfaces and uniform processing all contribute to the assurance of *lower cost per foot drilled* when you use Crucible Hollow Drill Steel.

So, when you say "Give me Crucible", you know that lot after lot is produced to chemical and structural uniformity—proven by performance under service conditions. What's more, you get fast field service, unsurpassed metallurgical assistance and country-wide stocks. Check with our local representative—he can help you.

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CRUCIBLE first name in special purpose steels

HOLLOW DRILL STEEL

HIGH SPEED • TOOL • STAINLESS • ALLOY • MACHINERY • SPECIAL PURPOSE STEELS

TIMKEN
MADE IN U.S.A.
Tapered Roller
TIMKEN BEARING
EQUIPPED

TIMKEN® BEARINGS

HELP KEEP IT RUNNING—KEEP THE AIR COMING

This Ingersoll-Rand ES-1 air compressor supplies the general air requirements of an entire plant. That's a real test of dependability.

Timken tapered roller bearings on the compressor crank shaft help to meet — and beat — this test by relieving the compressor of frictional drag, by protecting vital moving parts against radial, thrust and combined loads and by holding the crank shaft and adjacent parts in constant alignment.

Furthermore, Timken bearings, being made of Timken fine alloy steel — the best material ever developed for tapered roller bearings — possess tremendous strength and ability to resist shock and wear for long life and low maintenance wherever they are installed.

Make sure you have them in compressors and all kinds of equipment. The Timken Roller Bearing Company, Canton 6, Ohio. Cable address "TIMROSCO".

TIMKEN 50 YEARS

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL AND THRUST → ← LOADS OR ANY COMBINATION

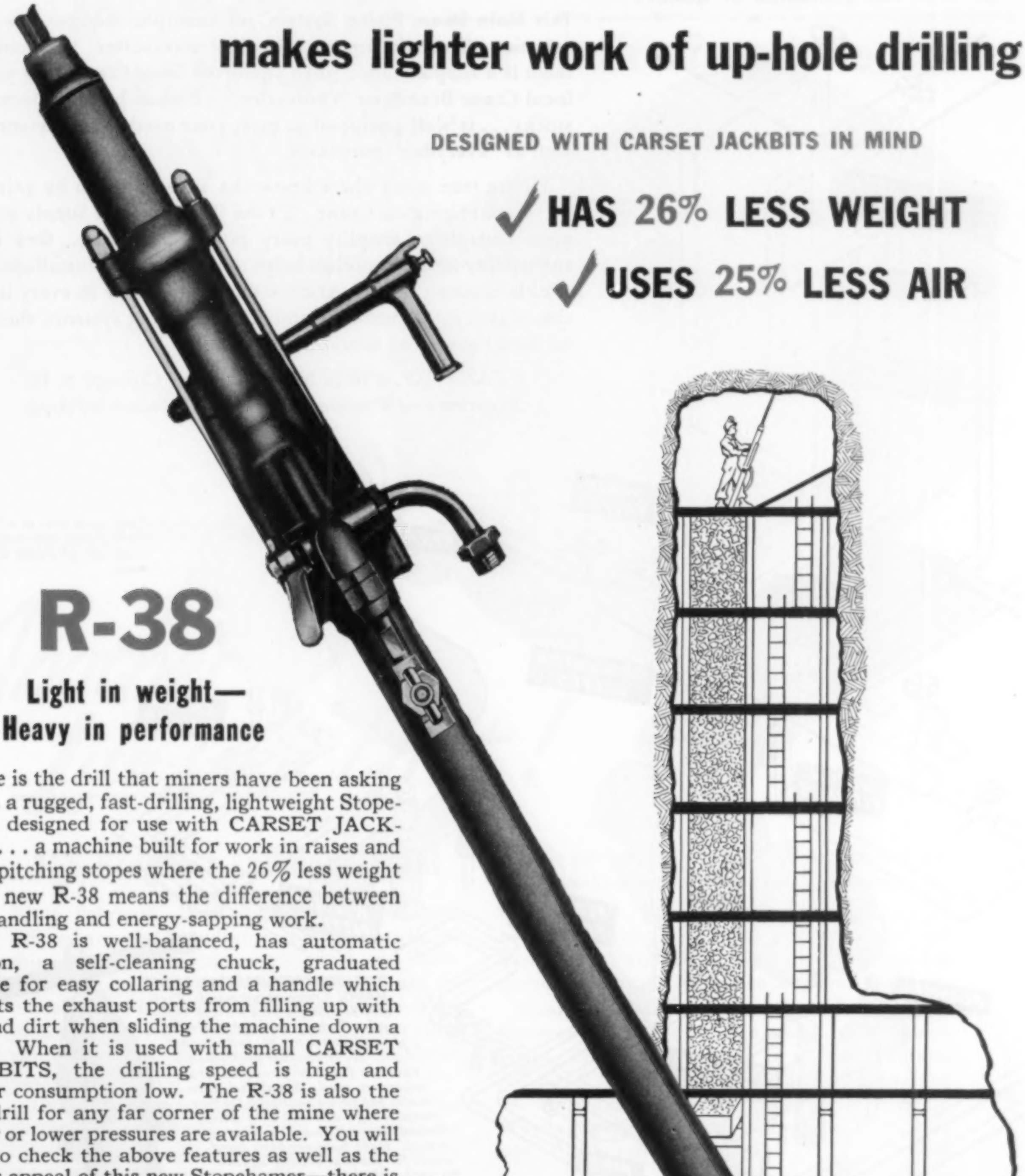
NEW 75-POUND STOPEHAMER

makes lighter work of up-hole drilling

DESIGNED WITH CARSET JACKBITS IN MIND

✓ HAS 26% LESS WEIGHT

✓ USES 25% LESS AIR



R-38

**Light in weight—
Heavy in performance**

Here is the drill that miners have been asking for . . . a rugged, fast-drilling, lightweight Stopehamer designed for use with CARSET JACKBITS . . . a machine built for work in raises and tough pitching stopes where the 26% less weight of the new R-38 means the difference between easy handling and energy-sapping work.

The R-38 is well-balanced, has automatic rotation, a self-cleaning chuck, graduated throttle for easy collaring and a handle which protects the exhaust ports from filling up with grit and dirt when sliding the machine down a stope. When it is used with small CARSET JACKBITS, the drilling speed is high and powder consumption low. The R-38 is also the ideal drill for any far corner of the mine where less air or lower pressures are available. You will want to check the above features as well as the worker appeal of this new Stopehamer—there is an I-R branch office within easy reach of your telephone.

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CARSET JACKBIT
SET WITH CARBOLOY INSERTS

For complete selection . . . better service

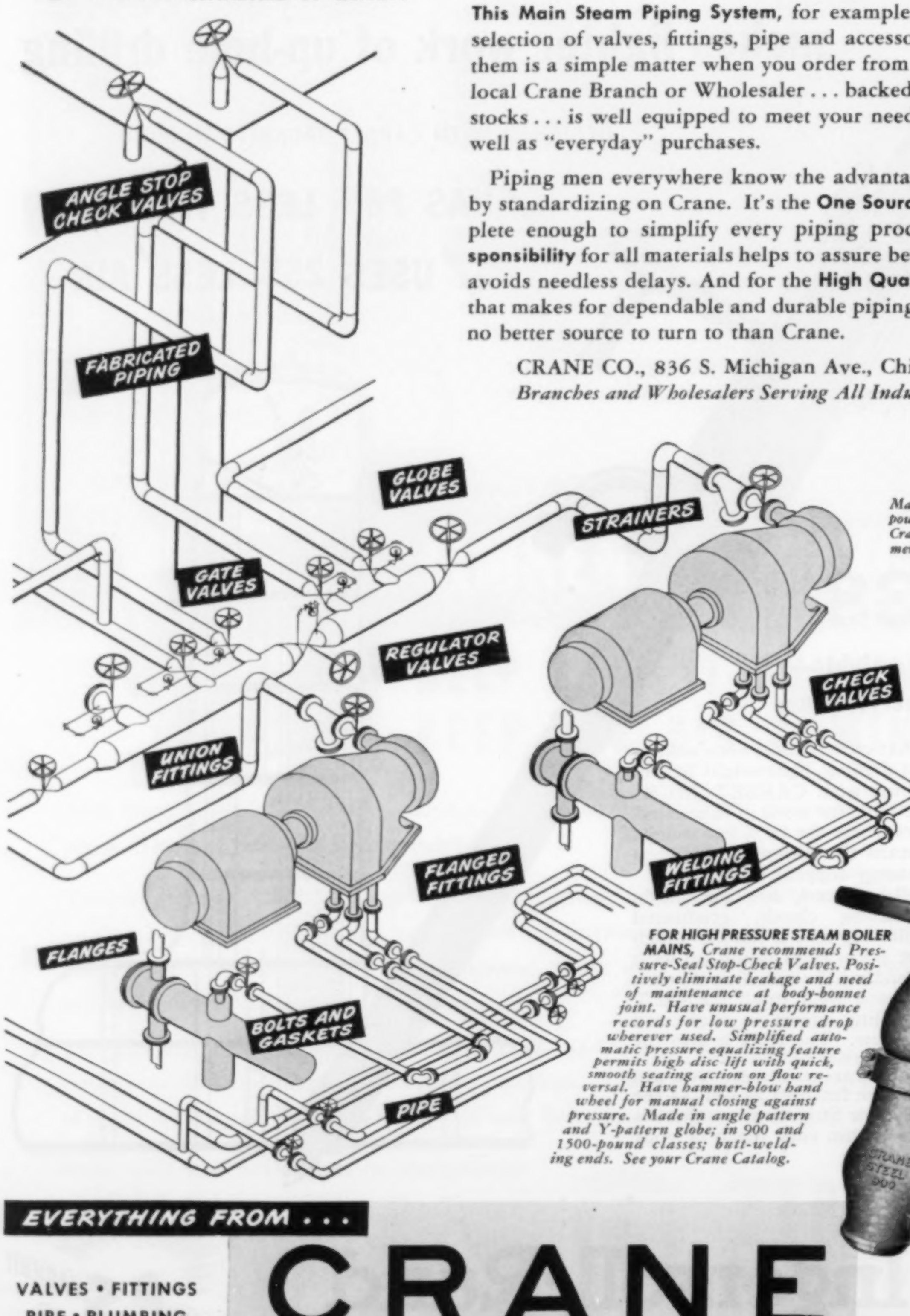
ONE SOURCE OF SUPPLY
RESPONSIBILITY
STANDARD OF QUALITY

Look to the CRANE line

This Main Steam Piping System, for example, requires a wide selection of valves, fittings, pipe and accessories. Yet getting them is a simple matter when you order from Crane. For your local Crane Branch or Wholesaler . . . backed by large factory stocks . . . is well equipped to meet your needs—infrequent as well as "everyday" purchases.

Piping men everywhere know the advantages to be gained by standardizing on Crane. It's the **One Source of Supply** complete enough to simplify every piping procedure. **One Responsibility** for all materials helps to assure better installations, avoids needless delays. And for the **High Quality** in every item that makes for dependable and durable piping systems, there's no better source to turn to than Crane.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas


ANGLE STOP CHECK VALVES
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BOLTS AND GASKETS
PIPE

Main steam lines in a large power plant; one order to Crane gets all piping equipment.

CRANE
STEEL
900

FOR HIGH PRESSURE STEAM BOILER MAINS, *Crane recommends Pressure-Seal Stop-Check Valves. Positively eliminate leakage and need of maintenance at body-bonnet joint. Have unusual performance records for low pressure drop wherever used. Simplified automatic pressure equalizing feature permits high disc lift with quick, smooth seating action on flow reversal. Have hammer-blow hand wheel for manual closing against pressure. Made in angle pattern and Y-pattern globe; in 900 and 1500-pound classes; butt-welding ends. See your Crane Catalog.*

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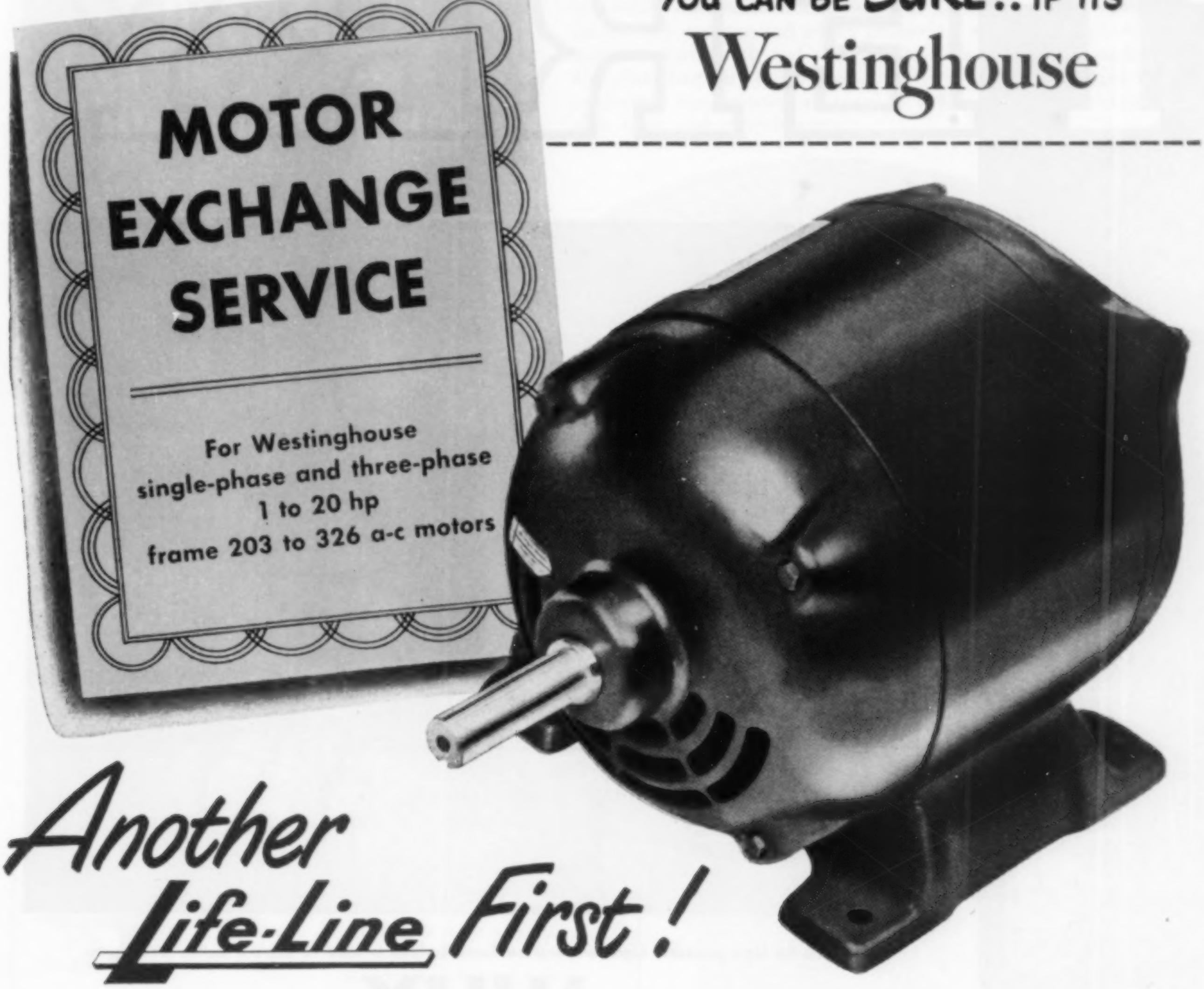
VALVES • FITTINGS
PIPE • PLUMBING
AND HEATING

FOR EVERY PIPING SYSTEM

YOU CAN BE **SURE**.. IF IT'S

Westinghouse



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EXCHANGE
SERVICE

For Westinghouse
single-phase and three-phase
1 to 20 hp
frame 203 to 326 a-c motors

Another Life-Line First!

The Broadest Exchange Plan!

Since February, 1949, Life-Line motors have offered you the broadest exchange plan in industry. All 1 to 20-hp, single-phase and three-phase a-c motors in frame 203 to 326 are included. No other manufacturer of motors—large or small—provides exchange service that compares in scope to this new Life-Line Motor Exchange Service.

120 Westinghouse exchange points assure you rush motor replacement service anywhere in the United States. Replacement motors, covered by this plan, are in stock, ready to be speeded to you at any time.

And what's more, if a motor fails during warranty period, it may be exchanged *free* for a motor of identical rating. The *exchange price,* beyond warranty, *is not dependent on the time in service . . . one year, five years or ten years.*

This service is one more advantage you get with Life-Line motors. Add this to all-steel construction . . . pre-lubricated bearings . . . an indicated savings of $750 per year per 100 motors . . . and you'll see why Life-Line has gained leading acceptance in the motor industry.

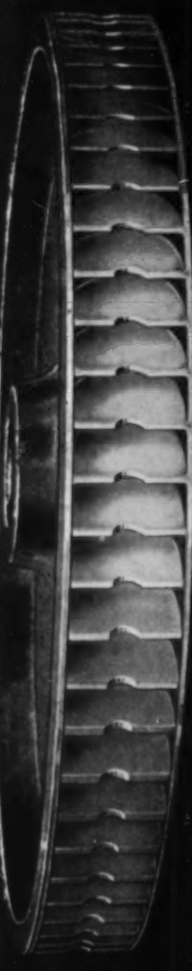
Complete details on the Life-Line Exchange Service—lists of exchange points and motor ratings covered—are given in the new booklet SM-5243. Get your copy today from your nearby Westinghouse representative or write direct to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Penna.

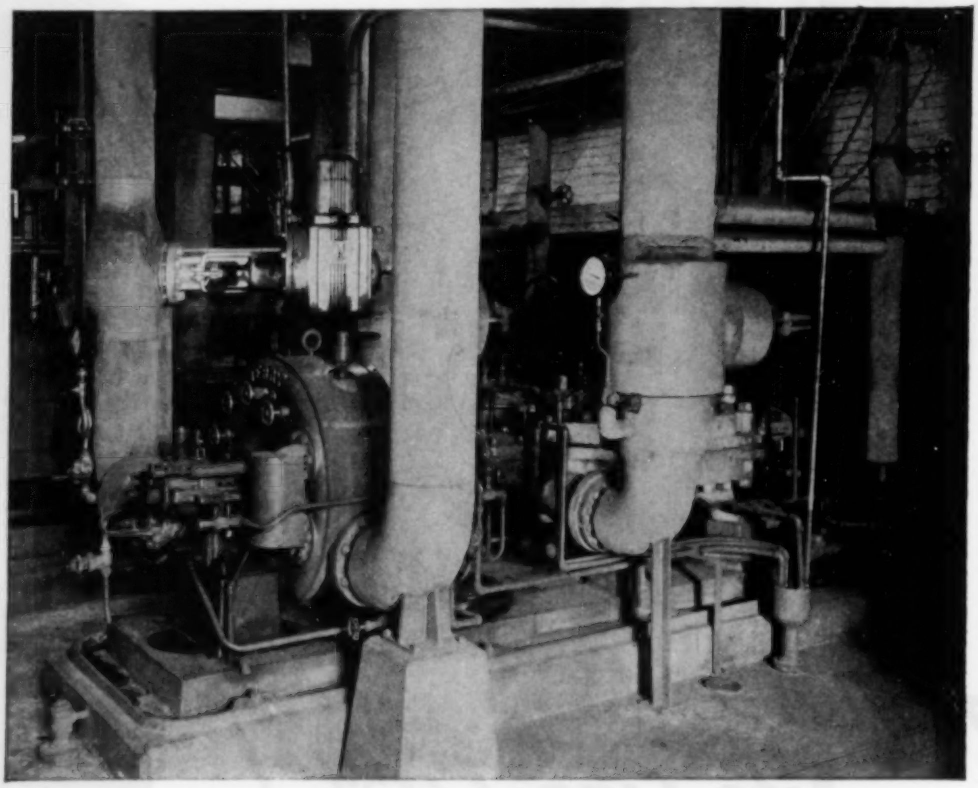
J-21533

Westinghouse
Life-Line
Motors

WESTINGHOUSE

TERRY





This 600 hp high pressure, high temperature Terry Turbine is used to drive a boiler feed pump.

WHY
AMPLE BLADE CLEARANCES ARE SO IMPORTANT

This Terry Turbine has large radial and axial clearances.

If radial clearance should become reduced, the blades are protected by projecting rims at sides.

The side clearance — one inch — is so large that possible end play from excessive external thrust can cause no damage to the wheel. And frequent inspection of thrust bearings is unnecessary.

Write us on your business letterhead for a copy of Terry Bulletin S-116 describing these construction features and other Terry advantages.

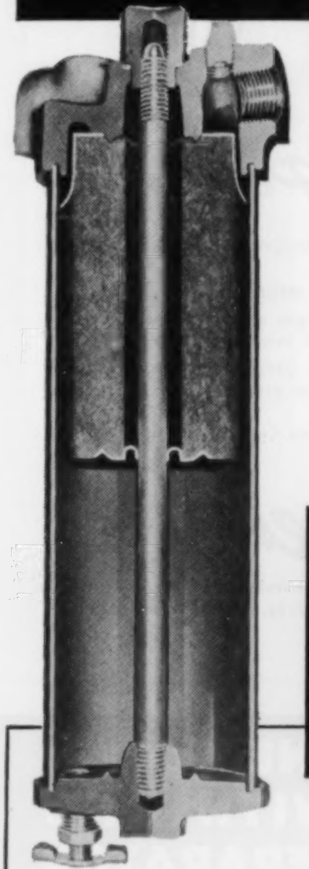
Our district representative will be glad to discuss your specific turbine drive problem with you.

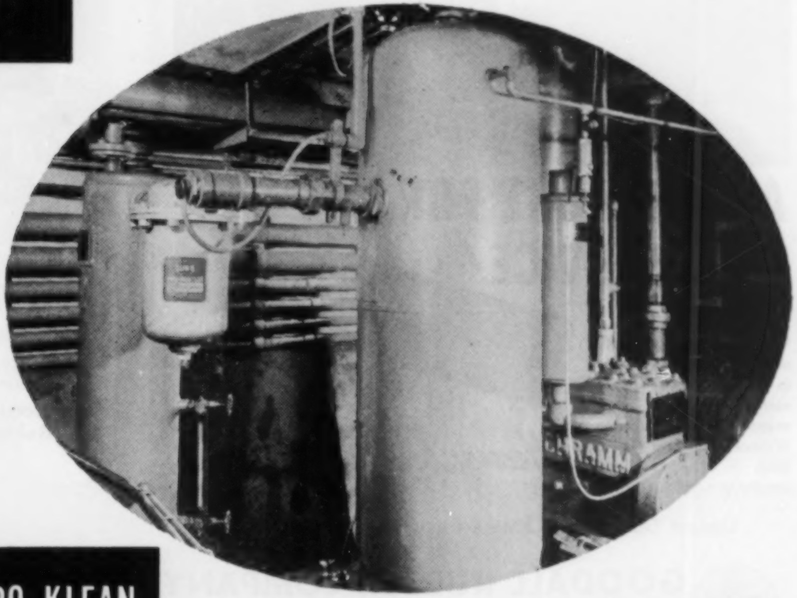
T-1173

THE TERRY STEAM
TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

Operation—"Air-Conditioning"

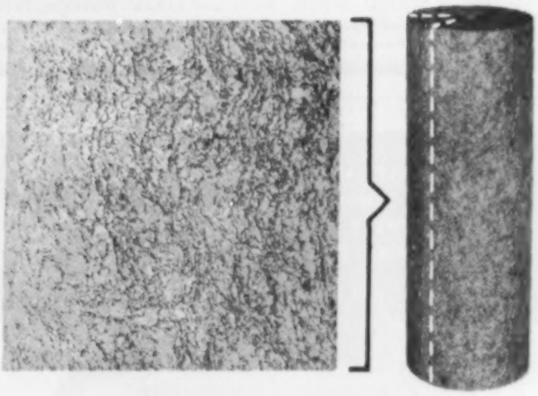
Dependable laboratory experiments require standardized materials and conditions. Sun Oil Company standardizes laboratory compressed air by removing oil, water, and other contaminants with a Cuno Micro-Klean Filter. Handling 150 cfm (free air) at 100 psi, the Micro-Klean provides the uniformly conditioned air vital to the accuracy of innumerable tests and experiments.





HOW MICRO-KLEAN COUNTERS CONTAMINATION

Air passing into the MICRO-KLEAN Filter first hits the baffle, deflecting some of the moisture down outside the cartridge. Any moisture remaining enters the cartridge where it must make hundreds of sharp turns, impinging on the non-wicking fibres, then draining into the extra-large collection chamber.



No Wicking or Channeling

An exclusive method of "felting" fibres creates a network of tiny interstices in the cartridge. "Graded density in depth" prevents clogging, doubles dirt-collecting capacity. Resinous impregnation and polymerization eliminates "wicking" and strengthens the cartridge, preventing channeling.

OTHER USES AS STANDARD EQUIPMENT: pneumatic machinery, spray painting, powder dispensing devices, etc. Models to handle volumes in excess of 450 cfm, pressures to 125 psi.

●Your nearby Cuno engineering representative, handling the broadest line of fluid filters, is your best source of unbiased recommendations on fluid filtration . . . he offers you, before and *after* installation, service based on years of experience with engineering filtration systems.

CUNO

Fluid Conditioning

Removes More Sizes of Solids from More Types of Fluids

MICRONIC • DISC-TYPE • WIRE-WOUND

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Please send information on Cuno Filter.

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The Goodall "Standard of Quality" hose you can rely on for safe, low-cost service in all heavy-duty air tool applications. Extra strong wrapped duck construction Wear-resistant red cover. Sizes ½" to 1¼", in lengths up to 50 feet.

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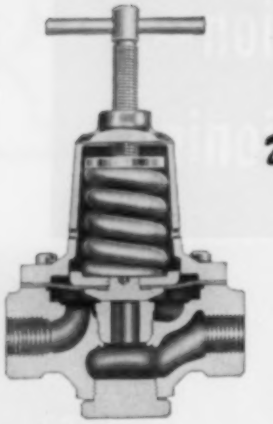

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NORGREN
Diaphragm-type
RELIEF
VALVE

Improves
Performance

1 Prevents damage to equipment through air and fluid lines.
2 Holds its relief pressure setting.
3 Large, exposed diaphragm area for positive valve action—greater flow at low pressure rise.
4 Metal-to-Metal seat for pressures up to 250 p.s.i. Rubber-to-Metal Seat for pressures up to 125 p.s.i.

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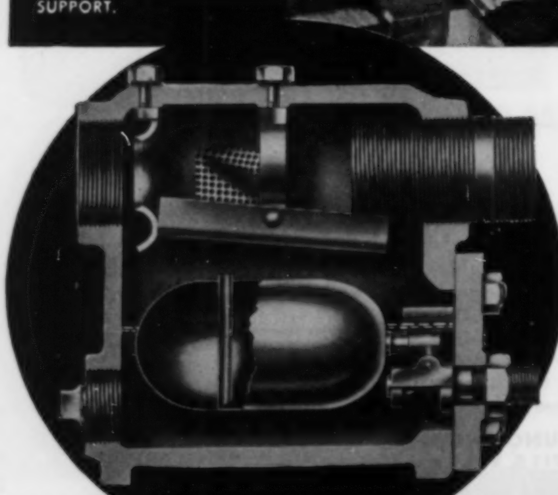
Lubricators, Filters, Regulators, Valves, Hose Assemblies.

DRI AIR MAY BE INSTALLED BY SUSPENDING IT FROM THE PIPING WITHOUT ANY OTHER SUPPORT.

INCREASED PNEUMATIC EFFICIENCY WITH THIS AUTOMATIC SEPARATOR



PROTECT EQUIPMENT WITH

DRIAIR

SEPARATES • COLLECTS • DELIVERS

• DriAir separates and automatically ejects the condensed water and oil from compressed air lines, collects pipe scale and rust, delivers clean dry air to tools and other pneumatic equipment. This promotes better lubrication, reduces wear, increases life of tools and produces greater output. All internal parts are made of bronze or copper—resistant to corrosion and practically permanent.

A TYPICAL INSTALLATION SHOWING DRI AIR STANDING ON A CONCRETE FLOOR NEXT TO THE WALL.

WRITE FOR BULLETIN DA WHICH FULLY DESCRIBES THE CONSTRUCTION AND OPERATION OF THE DRIAIR.

NEW JERSEY METER CO.

"SPECIALISTS IN COMPRESSED AIR DEVICES"

PLAINFIELD, NEW JERSEY

LOW COST PER UNIT OF WORK

Suppose you're considering two competitive brands of wire rope. They look alike, but one sells for a little less than the other. Bargain? Often it's anything but a bargain. For purchase price alone isn't the measure of wire-rope economy.

Sometimes you may find a wire rope with a lower price tag than Bethlehem's. But how does the cheaper one compare in total service rendered? How about its *Cost per Unit of Work?*

What a unit of work is depends, of course, upon the industry involved. It can be a ton of rock moved by a power shovel. Or a car of coal hauled up a slope. Or a ton-mile in oil-country rotary drilling. But in any case, unless your final rope Cost per Unit of Work is *low,* the rope has not done an economical job for you. That's why first cost—purchase price—isn't the sole yardstick.

Bethlehem wire rope is a quality product, one conscientiously built for long-range economy. When you buy it, you are spending your money wisely. You are buying wire rope that means, in the truest sense, *low* Cost per Unit of Work.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation

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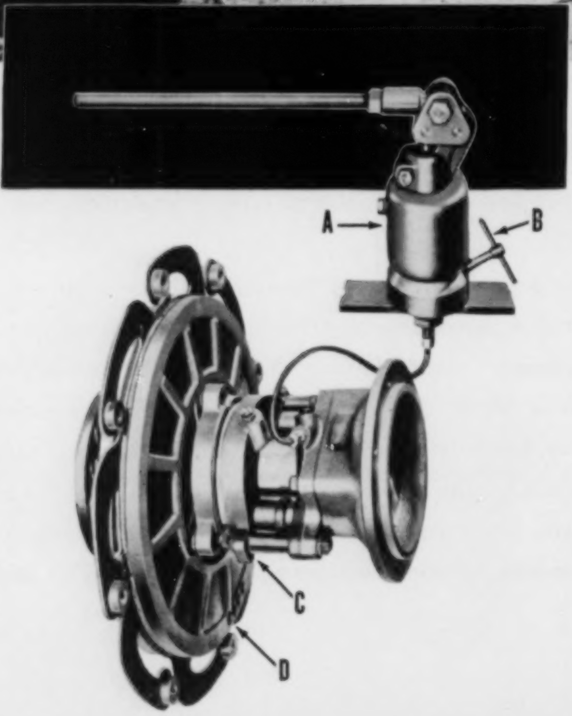

ON THE BIG ROCK REMOVAL PROJECTS

in heat or cold, in high altitudes or low, the I-R *Mobil-Air* Compressors with *Flex-Disc* Clutch and *Hydro-Shifter* are a reliable, continuous source of air to the drills and hammers. They are easy to start and keep going unattended letting the workmen stay on the job of getting out the rock. Here we see progress being made on the Colorado Big Thompson Project for water supply.

The *Flex-Disc* Clutch (D at left) meets the exacting requirements of portable compressor duty. Finger-tip hydraulic control is provided by the pump reservoir and handle (A) for disengaging, and the release valve (B) for engaging the clutch through the hydraulic jack unit (C). All parts are built for low maintenance and long service. The seldom needed replacements are readily made without disturbing the rest of the compressor.

INDUSTRIAL CLUTCH CORPORATION

Waukesha Wisconsin

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PUMP CONTROL
PRESSURE FLOAT AND TEMPERATURE SWITCHES

CATALOG

Square D offers a wide range of pressure, float and temperature switches for practically all sizes of water pumps, condensate pumps, vacuum pumps, air compressors, machine tools and other machinery involving pneumatic or hydraulic systems. Send for your free copy of Pump Control Catalog, with illustrations and specifications.

Square D Company, 4041 N. Richards Street
Milwaukee 12, Wisconsin

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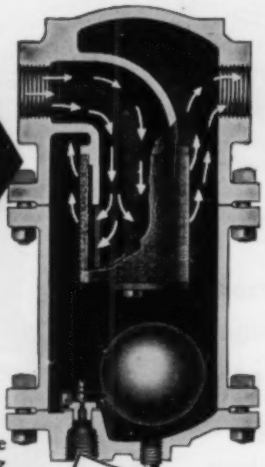
NO MOISTURE OR DIRT GETS BY HERE



Johnson Self-Draining Compressed Air Separator......

Like all Johnson Separators the new Type "SA" Self-Draining Separator combines the two most effective principles of removing moisture and dirt from compressed air:

1. Controlled expansion of air in separator precipitates most of the moisture.

2. A "thousand baffles" of coarse mesh repeatedly changes flow of direction to capture remaining foreign matter.

Johnson Separation Devices include Separators for Compressed Air or Steam. After coolers, oil absorbers.

Self-Draining—a simple but complete trap mechanism built right in, automatically drains separator whenever necessary.

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The Johnson Corporation

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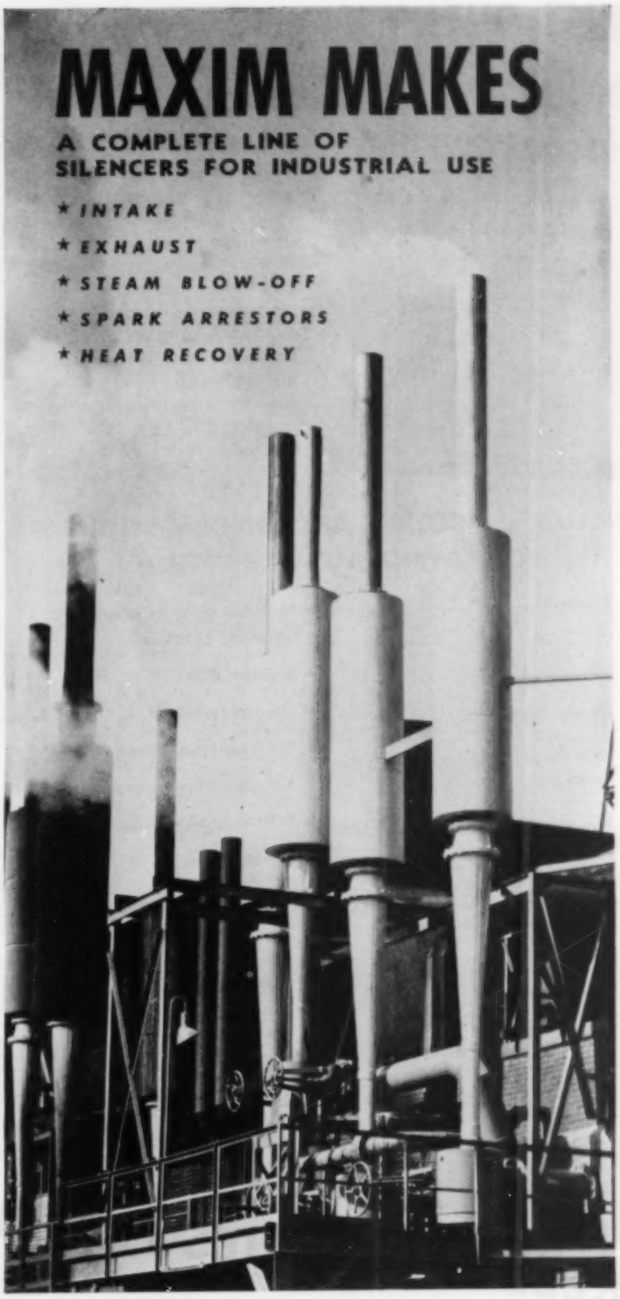

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- ★ SPARK ARRESTORS
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engineered air and oil filtration
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- Exhaust spark arresters
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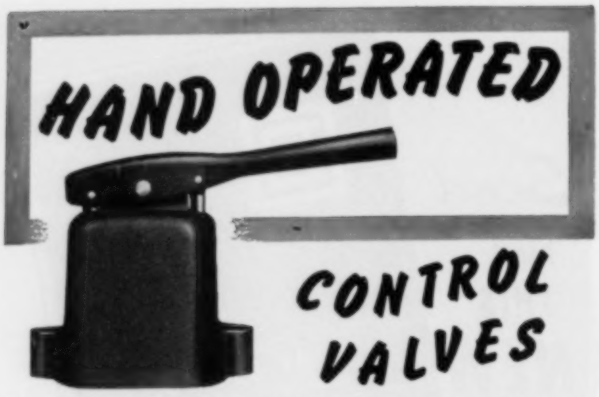
AIR-MAZE CORPORATION, CLEVELAND 5, OHIO



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AIR AND HYDRAULIC CONTROL VALVES

Mfd. by **C. B. HUNT & SON, INC.,** *Salem, Ohio*

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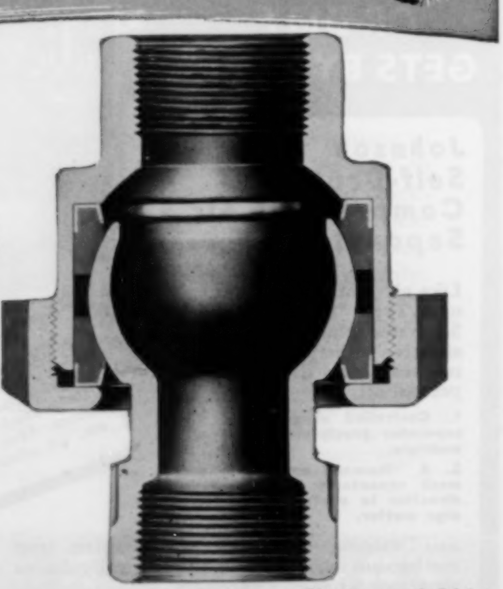
KEEP FLUID LINES FLEXIBLE

WITH BARCO JOINTS



Operators of air, steam or hydraulic equipment find it necessary to have flexibility in their pipe lines to move the equipment while operating, or to take care of vibration, and prevent pipe breakage. There is no better way to accomplish this purpose than by the use of BARCO FLEXIBLE JOINTS, in connection with steel pipe. This combination will stand temperature, pressure, and abuse, which no other form of container will stand.

Millions of BARCO Joints are in service all over the world, and they will give you just as good service as they have given others. Ask for technical information on your specific problems, together with prices and recommendations. Write Barco Mfg. Co., 1837 Winnemac Ave., Chicago 40, Ill. In Canada: The Holden Co., Ltd., Montreal, Canada.

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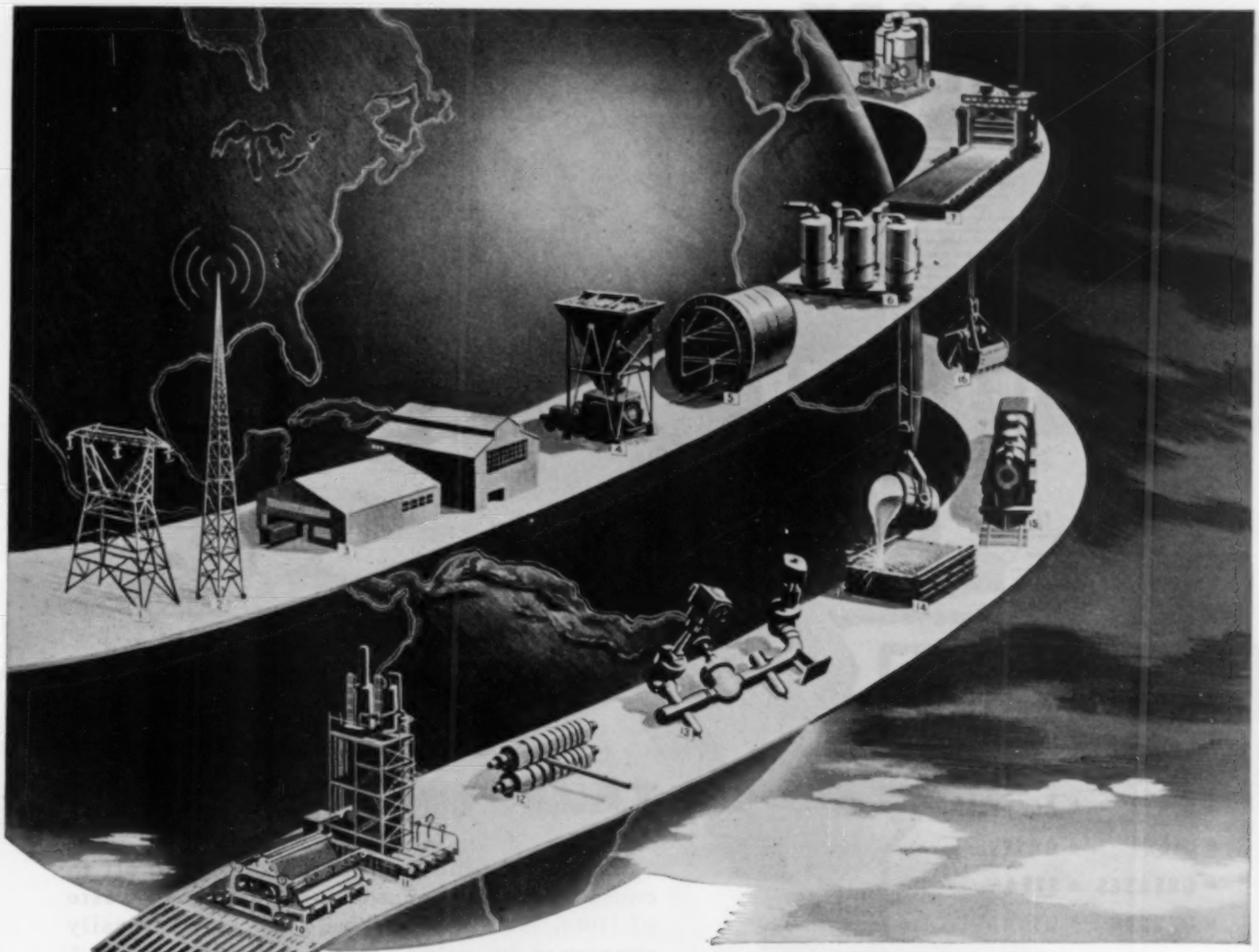
FREE ENTERPRISE—THE CORNERSTONE OF AMERICAN PROSPERITY

Not just a swivel joint ...but a combination of a swivel and ball joint with rotary motion and responsive movement through every angle.

"MOVE IN EVERY DIRECTION"



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Practically everywhere in the world, Blaw-Knox engineering skill, facilities, products and "know-how" are serving industry.

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CONNECTION TAKES ONLY A SECOND

Threading fluid line couplings on and off to connect or disconnect is an unnecessary waste of time. Any line can be quickly and easily connected by using a Hansen Coupling. And, in addition, couplings have shut-off features that prevent loss of the liquid or gas in the line.

When you want to connect a Hansen Coupling, it is merely necessary to push the plug into place, where it locks securely. The valve opens, and flow starts instantly. The same operation disconnects—move the sleeve, and the plug pops out. Flow is shut off automatically.

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If you have any fluid lines in your plant, you can increase efficiency, save precious minutes, by the use of Hansen Couplings.

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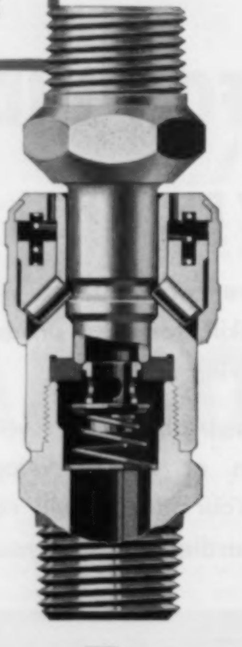

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GREATEN your manpower..
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Manpower turns out more work in less time when provided with dependable, light weight Ingersoll-Rand Air Tools. Air Tools help men to do the job faster, with less fatigue, with more accuracy and with greater uniformity.

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Call, wire, or write your Ingersoll-Rand branch office today and have an I-R Air Tool Specialist visit your plant — put his years of experience in varied fields to work for *you.*

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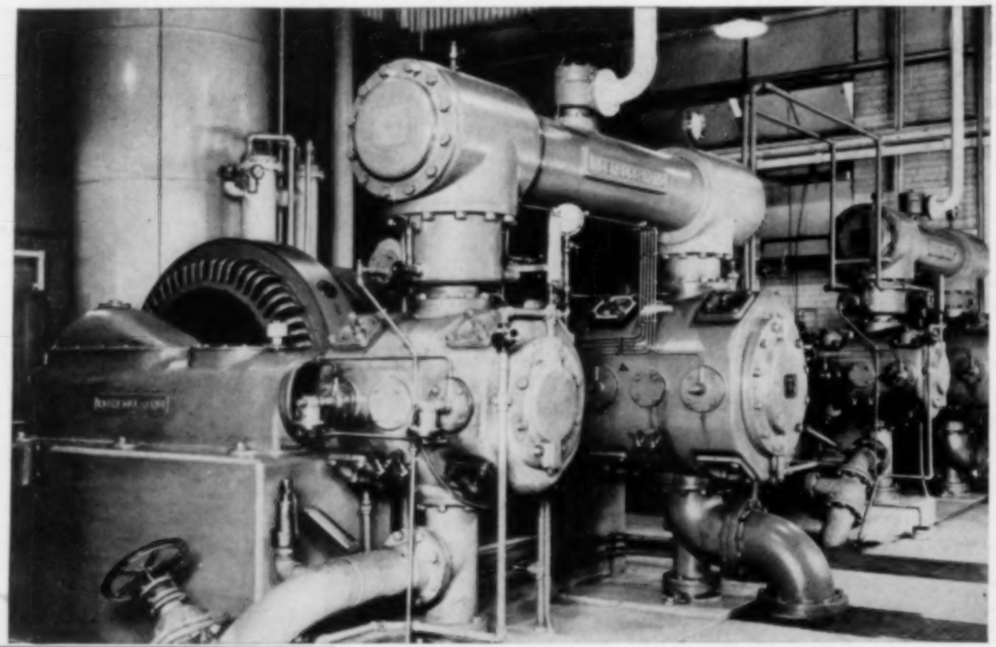
Is rust a threat?
Is service severe?
Are carbon and gum problems?
Is water present?
Are conditions normal?

GET BETTER PERFORMANCE FROM YOUR COMPRESSORS— regardless of operating conditions



Use Texaco air compressor oils and Texaco Lubrication Engineering Service

No *one* lubricant can assure top compressor performance under *all* conditions. So Texaco makes a complete line of air compressor oils . . . and a Texaco Lubrication Engineer will gladly help you select the right ones to give you greatest efficiency and economy whatever your operating conditions.

For example, Texaco recommends straight mineral oils for regular service . . . rust-inhibiting oils where rust is a threat . . . heavy-duty oils for especially severe service, or where carbon and gum are problems . . . compounded oils where water is present in cylinders during operation.

There are Texaco air compressor oils to meet every condition . . . to keep valves clean, rings free, ports open and air lines clear . . . reduce wear . . . and bring your maintenance costs down.

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